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The Welding Engineer

Edited by L. B. Mackenzie

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Heavy welds usually requiring special water cooled torches can now be handled with a
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No. 6 Non-Flash Heavy Duty Welding Torch
Torchweld Equipment Company
Fulton and Carpenter Streets
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High Grade Welding and Cutting Apparatus, Portable and Generator Outfits, Welding Rods, Fluxes and Accessories

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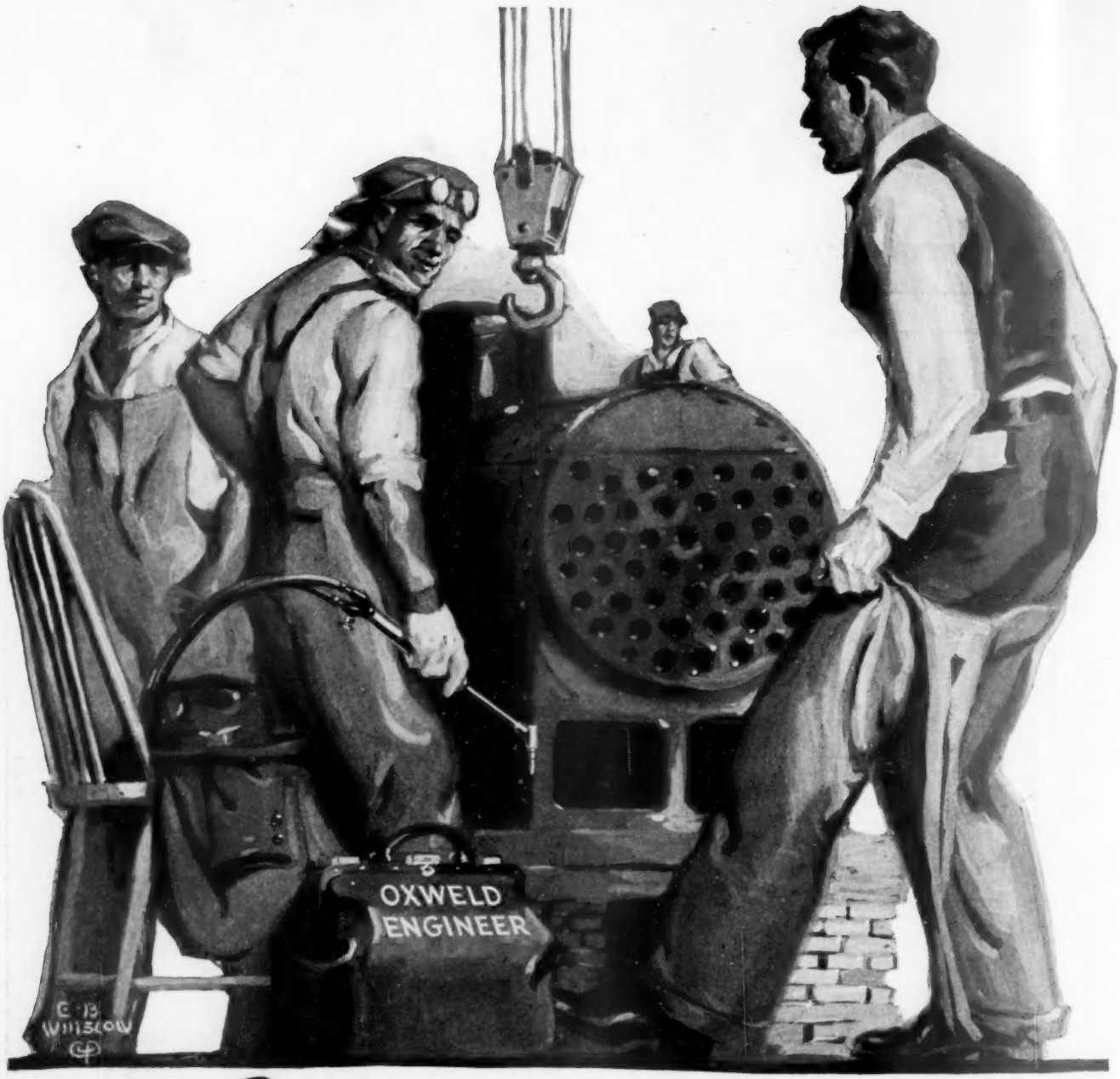

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Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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Commercial Acetylene Welding Co.
Universal Oxygen Co.
Prest-O-Lite Co.

ACETYLENE (Dissolved)
Air Reduction Sales Co.
Linde Air Products Co.

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BLOW TORCHES (Acetylene)
See "Torches"

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The Welding Engineer
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See "Torches"

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in 48 minutes

trims to correct flange height, with beveled calking edge, at one operation a 15-ft. dia. Scotch Marine Boiler Head, with the oxy-acetylene cutting torch.

—no chipping!
—no grinding!

in 48 minutes

against 20 to 30 hours by former methods of hand chipping and grinding.

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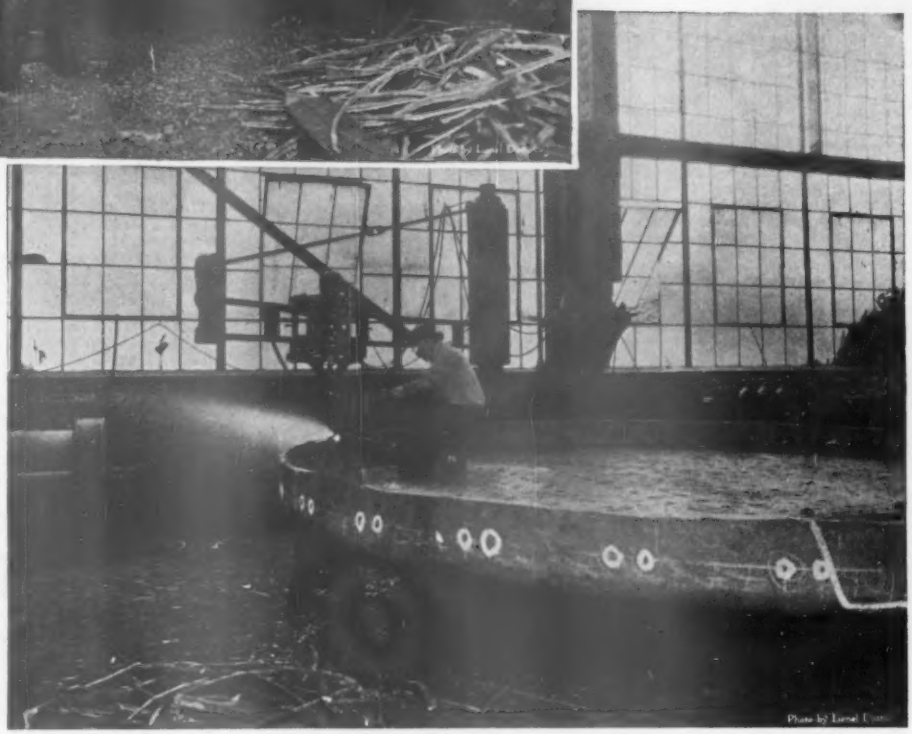
in operation at Federal Shipbuilding Co.'s plant, motor driven (⅛ H. P.), automatically follows any shape of flanged head, round, oval, oblong or irregular. It is one of several exclusive developments of the D-B Co. for mechanical cutting and welding with the oxy-acetylene and oxy-hydrogen process, employed in fabricating plants, including locomotive and boiler shops, shipyards, rolling mills, foundries.

Photos by Lionel Dottin, Federal Shipbuilding Co.



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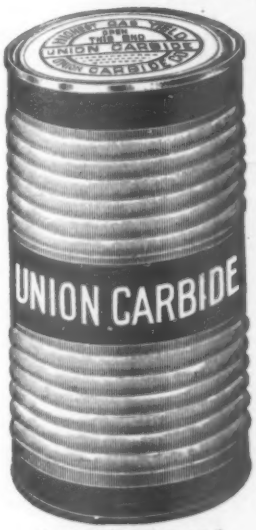

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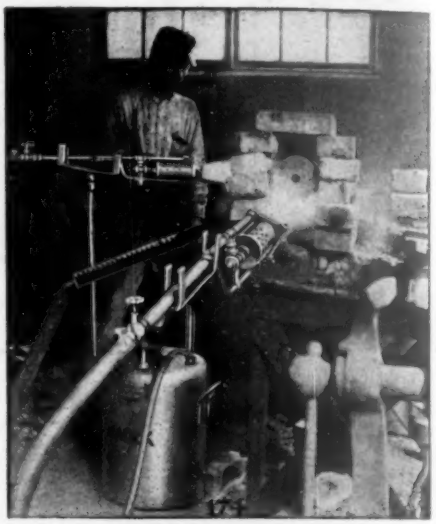

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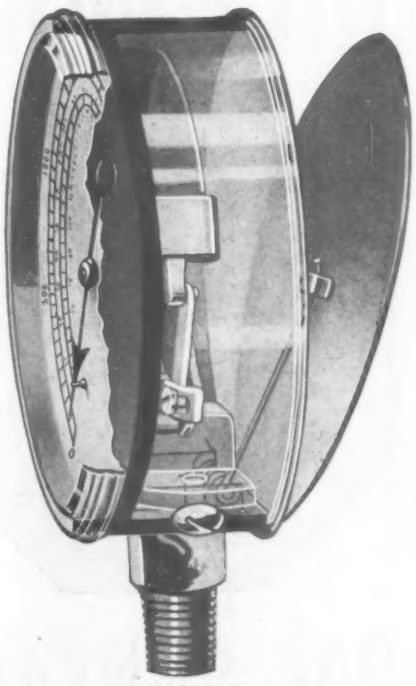

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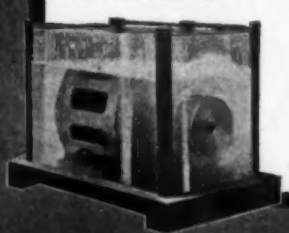

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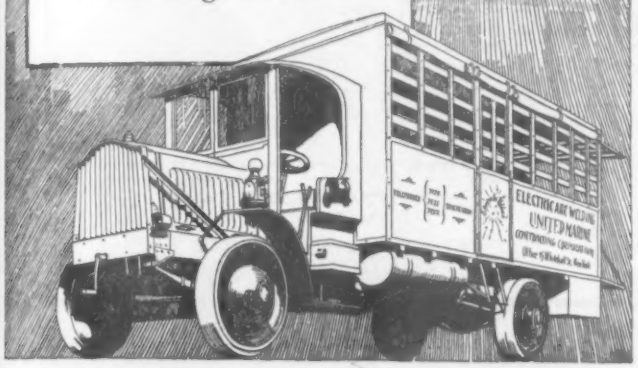

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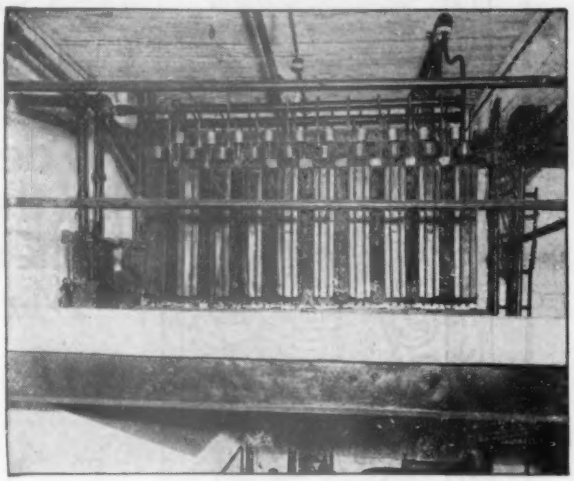

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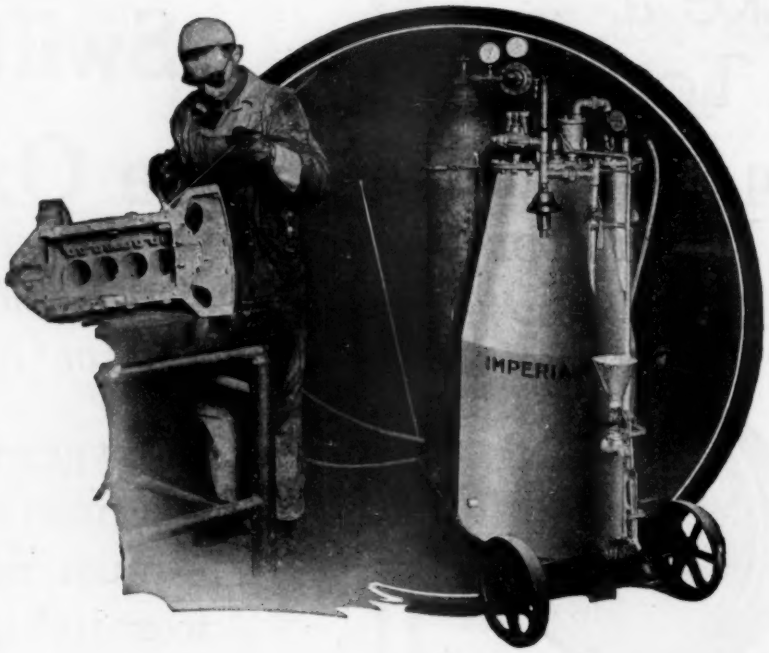

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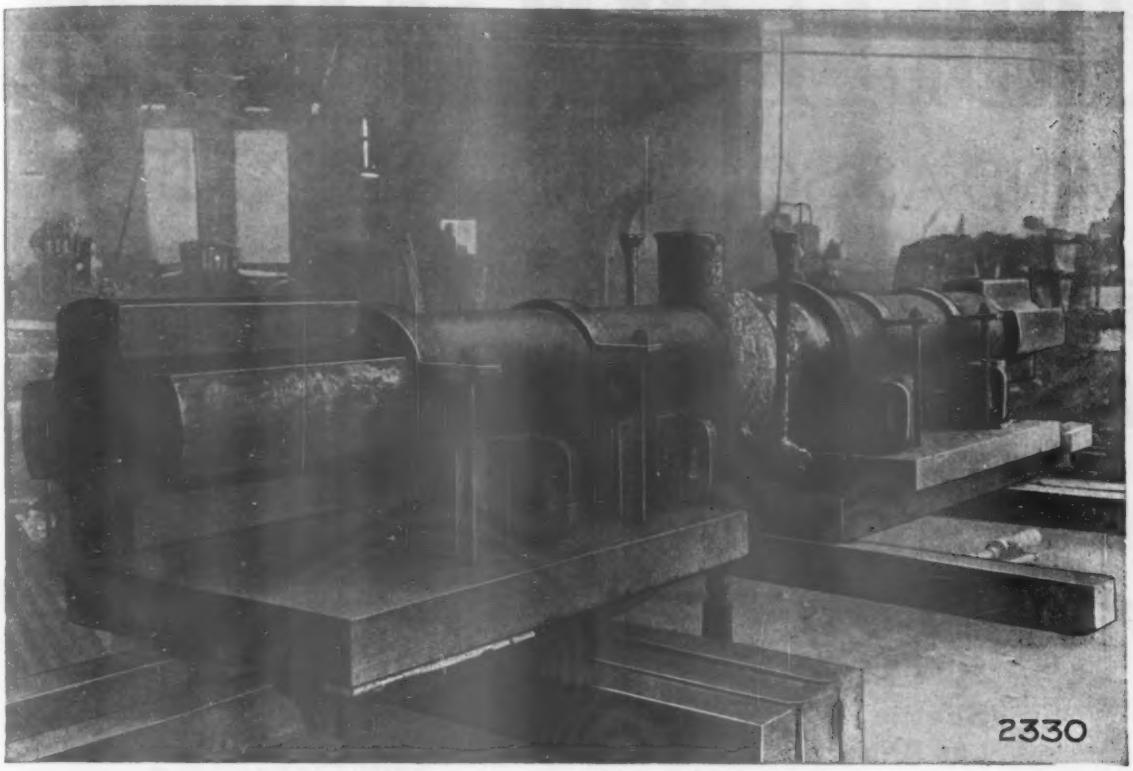

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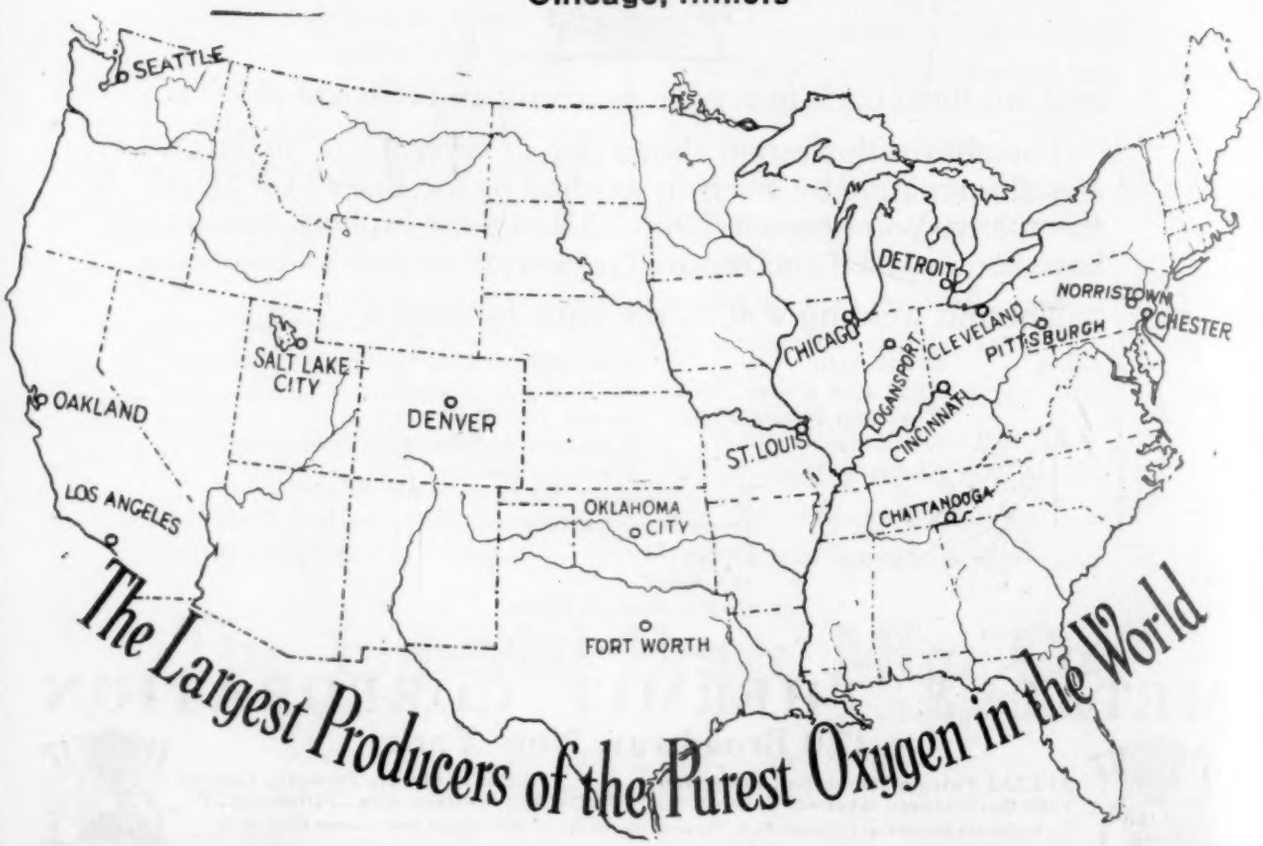

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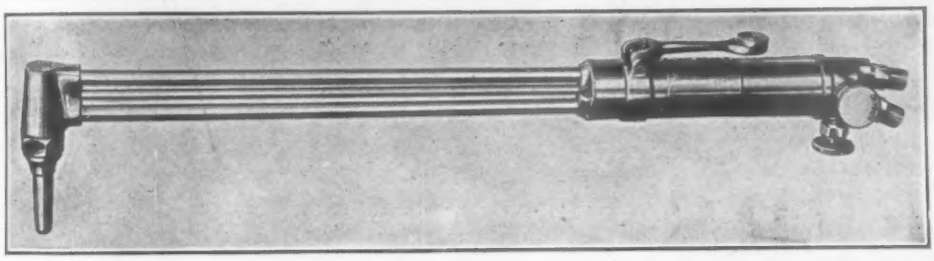

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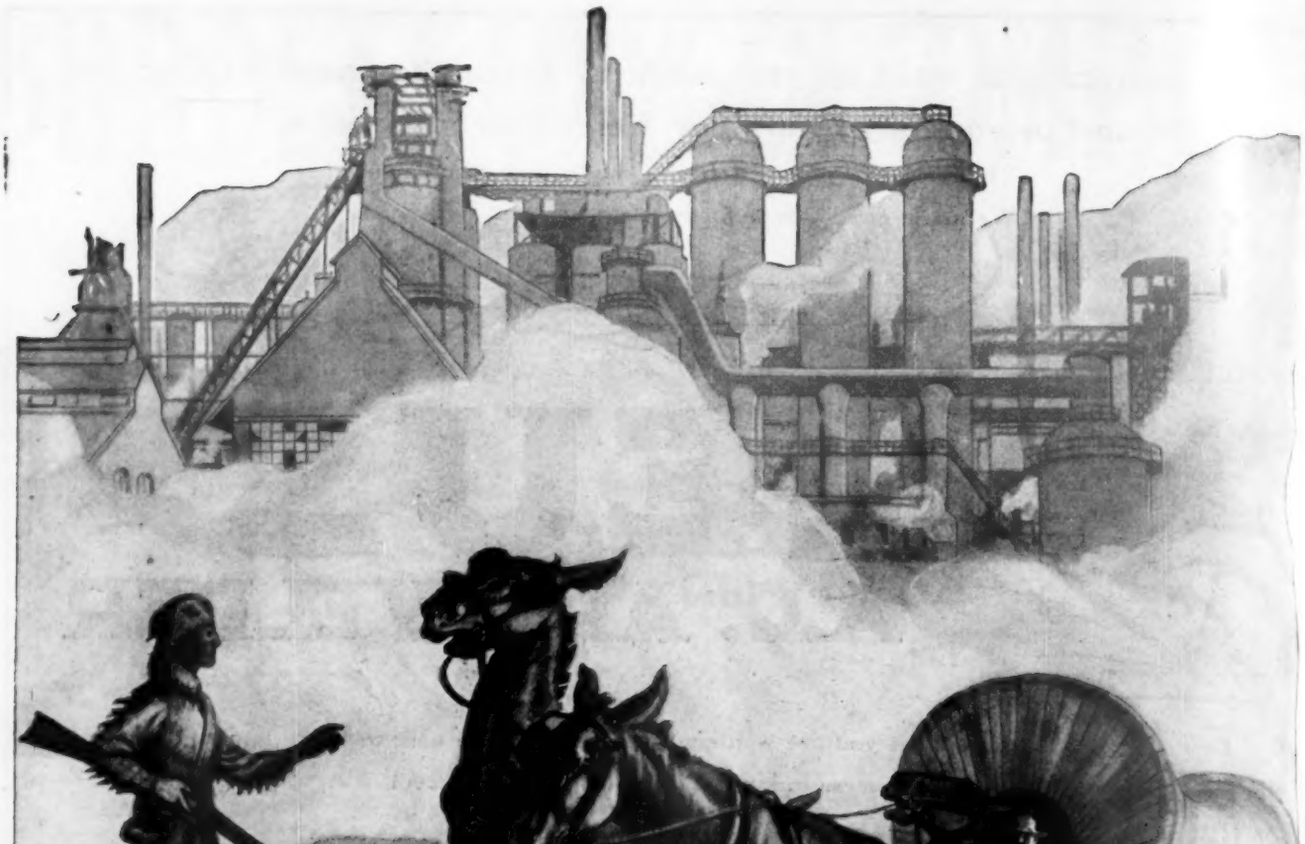

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CHARACTERISTICS PECULIAR TO OXY-ACETYLENE WELDS

By Alfred S. Kinsey*

ABOUT fifteen years ago, a mechanic in one of the railroad shops of the Central West made a torch for the use of oxygen and hydrogen in the cutting of metals. This soon was followed by a successful trial of acetylene in place of hydrogen, both for cutting and welding metals, and from that time the oxy-acetylene blowpipe has been an accepted tool for the quick repairs of railroad machinery. That it has been just as successful in other shops is well known, and we have but to consider the extensive use of the oxy-acetylene torch to appreciate its value to the mechanical world.

This new way of making welds was quite different from that employed for the old forge weld. In the old way, the job was taken to the fire; by the new method, the fire was taken to the job.

There was also a marked difference in the metallurgical principles used to make the weld. The forge weld depended on heating the metal to a soft plastic condition, a sparkling heat, and then forcing one mass into the other by hammer or press, producing a joint by plasticity. On the other hand, the ends of the job to be gas welded were brought to the molten condition by a blowpipe, so that there could be a complete flowing together of the metal of the two ends, a thorough mingling of the grains, making a strong weld by the principle of fusion. This gave the process the name of Autogenous Welding, meaning a joint made by the fusion of its own metal. This would not apply, however, when a welding rod is used, as it is in most cases, so the term has become less common.

The substitution of the oxy-acetylene fusion weld for the forge plastic weld has been given careful study and its application watched closely by those who needed it most—the master mechanics and shop superintendents. Many tests of such welds have been made and sufficient data obtained to establish a standing for the process. It is also significant that the technical engineer has given so much attention to the process, particularly during the past year.

It will, therefore, be of interest to emphasize the prominent characteristics peculiar to oxy-acetylene welding.

Fusing Metals

The problems involved in the handling of metals while in the molten condition are well known. To expose molten metal to the air means to oxidize it. The purest steel is melted in a covered crucible, a cupola must be fluxed to overcome the oxidation of the melting iron, powdered charcoal is spread over the surface of molten brass in the foundry ladle to prevent the formation of oxides, so to melt with an oxy-acetylene torch in the open air introduced the thought of oxidation. But here is an exception to the rule, the oxy-acetylene flame can melt metal without seriously contaminating it with oxides, if used properly it will produce practically perfect fusion. Of course, there is an explanation for this. Let us imagine the oxy-acetylene flame of a torch pressed down on some metal to be melted for welding until the incandescent cone of the flame almost touches the job. The surface of the metal being brought to the melting temperature is then completely enveloped by the flame, which as it burns forms hydrogen and carbon monoxide. These two gases in turn pass to the edges of the envelope where they go into combustion with the air, forming water vapor and carbon dioxide. The hydrogen and carbon monoxide have an affinity for oxygen, which causes the flame to absorb and consume any normal excess oxygen from the air or the torch. This is what prevents the oxidation of the molten metal of the weld, when the flame is properly adjusted, and is what largely has made the oxy-acetylene process so successful.

It will be understood, therefore, that the chief drawback to successful fusion welding, i. e., oxidation of the molten metal, need not apply to the oxy-acetylene flame so far as a commercially strong weld is concerned.

Its reducing, non-oxidizing nature will be appreciated by men who have to do with the melting of metals, and especially by those who are interested in making welds. To be able to produce a molten area on the surface of a piece of any kind of metal, without oxidizing it, to easily keep it under temperature control, and to locate the melting just where it is desired, all form an asset of no mean value to the metal working industries.

Physical Efficiency

The general physical effect of making welds by gas fusion is of first concern. How is the granular structure affected? What is the loss in tensility and ductility? How are the chemical contents affected? These questions may be answered with authority. Many careful, practical and laboratory tests have been made of oxy-acetylene welds, from which may be drawn reliable conclusions. We know that plans are now being considered for a more comprehensive series of tests of welds made by the four common methods, the results of which undoubtedly will be studied with much interest.

The granular structure of oxy-acetylene welds need not be impaired by the use of the torch. There will be, of course, some change in the grain formation, due to the melting of the

*Professor of Shop Practice, Stevens Institute of Technology. Paper presented to Joint Meeting, New York Section American Society of Mechanical Engineers and American Welding Society at New York, April 13, 1920.

metal, especially in the case of steel, where it would be transformed from a forging to a casting. This would lower the granular cohesion due to the grains being somewhat separated. However, most of this effect may be overcome by hammering the metal at a red heat as the weld is being made. Carelessness, of course, may cause permanent separation of the grains by oxidation but there is no excuse for this in oxy-acetylene welding.

Some oxy-acetylene welds have shown granulation and crystalization, especially in a metal whose oxides melt at a higher temperature than the base metal. Again there may be found granular segregation and cleavage lines. These defects, however, are most always due to lack of skill or carelessness of the welder, even as the old forge weld very frequently was found to be defective from the same cause.

Unequal granular strains are also sometimes to be found in fusion welds, but they may be avoided if the welder does his work properly. Reheating and annealing of a weld will usually eliminate such weaknesses.

The granular problems common to fusion welds may, therefore, in most cases never be found in oxy-acetylene welds, and when they do appear, they most always may be solved quickly and satisfactorily.

Tensile Strength Effect

Again, the making of a fusion weld frequently affects its tensile strength, not alone to reduce it below normal, but sometimes to unfavorably increase it beyond its original strength by brittlizing the metal. In the gas weld, the tensility of the metal may be preserved without setting up unnecessary granular strains, and it is not unusual to get figures of from 90 to 100 per cent of the original tensile strength. This was not so true in the early days of oxy-acetylene welding, as welders then were more prone to ignore the importance of bringing about perfect amalgamation between the base and added metal of the weld. In the gas weld, it is possible to use filler rod with a tensile strength greater than that of the job being welded. In fact, there is no reason why it should not be the common thing to find oxy-acetylene welds giving nearly 100 per cent tensile efficiency. It is a matter of physical relation of filler rod metal to base metal. For example, if it is desired to make certain that a weld of medium carbon steel will have 100 per cent tensile strength, it will be quite possible to use a filler rod of nickel steel whose tensility is far beyond that of the steel of the job and by this combination produce a weld of 100 per cent tensile efficiency.

Another important physical characteristic of the oxy-acetylene weld is its ductility or bending qualities. That is, this type of weld can be made without serious loss of elongation and reduction of area. The problem of the ductility of welds has received more consideration than any other physical characteristic. With some types of welds it is still a serious matter. Let us visualize the conditions controlling the formation of a good weld in order to see why this is so. It is well known that the grains of the common engineering metals are flatsided, some having four and others having as many as eight sides. These grain faces are held together by the law of cohesion. To pull them straight apart requires but little effort for a soft metal like lead, but it takes over 200,000 lbs. per square inch of the whole mass to accomplish the same thing with some steels, when cold. This is what is called the tensile strength of the metal. There is another way, however, to overcome this power of cohesion and that is by melting the metal. Then there is so little cohesion left to hold the grains together that it is easy for impurities like oxides to get between the grain surfaces and prevent the law of cohesion operating properly. This is noticed particularly in bending a piece of oxidized steel. In a clean normal condition the grains slide one over the other as the metal is bent, thus giving the highest ductility for the metal. But when the grain surfaces are oxidized, this sliding action is impeded, and the ductility is destroyed, that is, the steel will not bend without breaking. Therefore, the chief liability of destroying the ductibity of a weld is that of oxidizing its metal while in the molten condition, which emphasizes one of the strongest advantages of the oxy-acetylene process.

We may speak briefly of the loss of the chemical elements of a weld made by the oxy-acetylene torch. Let us keep in mind that these elements are very different in nature, some burning out freely, others acting as absorbants to draw in undesirable gases. Probably carbon is the element most seriously considered in the welding of irons and steels. A valuable characteristic of the oxy-acetylene flame is its ability to instantly replace any carbon which may be withdrawn from the molten metal. In fact by increasing the acetylene supply a little beyond the proper amount to maintain a neutral flame, a liberal amount of carbon may be added to the steel being welded if its initial content is low enough to permit of the absorption. In fact some case hardening is being done this way.

Utility of the Process

Another characteristic peculiar to the oxy-acetylene weld is its application to all kinds of metals, which means both the non-ferrous as well as the ferrous groups. The successful welding of cast iron alone would establish a high value for the gas process of welding, but to this may be added the welding of copper, brass, bronze, aluminum, lead, the common steels and now the most modern high speed and alloyed steels whose chemical constituents are of a highly volatile oxidizing nature. Indeed it is quite possible to cross-weld these metals, as copper to brass, steel to bronze, even though the melting temperatures may be widely different.

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ELEMENTS *of* ARC WELDING†

By O. A. Kenyon*

ARC welding is one of the oldest practical applications of electrical energy, having been put into actual commercial operation over 30 years ago.

The first practical development of arc welding utilized the carbon arc and was the subject of a patent granted to Bernardos. According to Bernardos' process, an arc is struck between a carbon electrode and the metal parts that are to be joined. With the arc in operation, a filler rod of material similar to the parts to be joined is inserted in the arc and fused by its heat.

The next important step in the development of the arc was made by Slavianoff, who invented a semi-automatic metallic arc process in which the filler rod itself is used as an electrode. The arc is struck between this electrode and the parts to be welded and the end of the electrode melts, fusing in the joint with the parts to be joined.

In the early days, metallic electrode welding was done with comparatively high-voltage constant-potential generators, a ballast resistance being connected in series with the arc and Swedish or Norway iron was used as electrode material.

The high-voltage generators and the iron electrodes made a combination that was peculiarly sensitive to variations in welding technic, and therefore, metallic arc welding was not considered much of a success from the practical standpoint.

In 1907, Kjellberg invented the coated electrode which was an exceedingly important contribution to the art at that time, because the coating of the electrode improved considerably the melting characteristics of the iron electrodes, and in that way, steadied the arc and made welding very much easier.

I became interested in arc welding in 1911, when I was first employed as consulting electrical engineer by the Electric Welding Company, which has recently been organized to exploit the Kjellberg process in this country. I found them using the coated electrode exclusively. They claimed that by adding ingredients to the flux coating on the electrode, they could produce various alloy steels. They also claimed that overhead welding was possible only when flux coatings were used, and I had charge of tests in which it was proven that with the flux coated electrode, overhead welding went forward without any metal dropping off the end of the pencil, while without the coating it just poured off under the floor. This was a great mystery and in explanation of this phenomena, I decided that pinch effect was the agency that made it possible to lift the metal off of the end of the pencil—the function of the coating being to prevent the metal from running off the end of the pencil before a sufficient quantity had been accumulated in the refractory cup at the end of the pencil to enable the pinch effect to operate. I am telling this simply to illustrate the depth of our ignorance at that time.

In spite of the fact that we have learned a great deal about arc welding and have made considerable improvements in arc welding equipment and practice, and above all have enormously extended the use of arc welding, it must be admitted that we do not make any better arc welds nor any stronger welds today than were made by the welders originally brought to this country from Sweden by the Electric Welding Company.

In all arc welding operations it is possible to divide the problem from a practical standpoint into seven elements, namely:

1—Type of joint.
2—Size of electrode.
3—Material of electrode.
4—Welding current.
5—Length of arc.
6—Method of holding parts.
7—Welding technic.

Perhaps the easiest and quickest way to get an idea of the practical working of arc welding is to consider these seven elements one at a time.

Type of Joint

Unless a structure is designed especially for welding, the welding engineer is often limited as to the choice of joint best adapted for the purpose. From the welding standpoint, all joints may be divided into two classes.

1—Single-line.
2—Double-line.

The single-line joint is one in which the edges to be welded are in contact throughout the entire cross-section, and the welding takes place by advancing the arc in a straight line, depending entirely upon penetration of the fusion into the parts to be joined for depth of the weld. The use of this joint is confined mostly to sheet metal or thin plate. Its use is limited only by the depth of penetration that can be obtained.

The two-line weld includes all welding where the surfaces to be joined are not in contact throughout their entire area. Therefore, there are many different kinds of joints included in this type and also many different ways of manipulating the electrode.

All two-line welds require a back and forth motion of the electrode which is called "weaving," and as far as weaving is concerned, we may divide all two-line welds into three general classes.

1—Crescent weaving.
2—Zigzag weaving.
3—Spiral weaving.

Crescent weaving is best adapted to all places where two edges with an intervening air-gap are to be joined.

Zigzag weaving is best adapted for downward welding where two intervening diverging surfaces are to be joined.

Spiral weaving is best adapted to joints where intersecting and diverging surfaces are to be joined, the direction of the joint being in a more or less vertical direction.

All foregoing joints are of the seam type and in many cases a seam weld gives more strength than is required. In such instances, it is often possible to employ a rivet weld which is made by providing one of the parts to be joined with a hole and lapping it over the other part, then welding through the hole in such a way as to fuse the two parts together and fill the hole. A seam of this kind if laid out as far as spacing is concerned, in exactly the same way as a riveted joint, will show about the same strength for a single row of rivet welds as can be obtained with a riveted joint and a double row of rivets of the same size. This has been established by tests and holds true for plates taking 1⅛ inch and larger rivets. Where thinner plates are concerned, it is necessary on account of welding conditions to use larger holes for the rivet weld than would be used for rivets, and consequently the ratio of strength is even greater than the thin plates.

While it may seem as though the type of joint under ordinary conditions should be one of the simplest elements in the entire welding problem, yet there are very few even among the

†Paper presented to Joint Meeting, New York Section, American Society of Mechanical Engineers and American Welding Society at New York, April 13, 1920.

*Engineer, Ray D. Lillibridge, Inc.

welders who are capable of choosing a joint that will give the best results from all points of view.

For instance, taking a joint of a given design and varying simply an air-gap, it will be found that as the air-gap increases from zero the pounds of metal per hour deposited for a given current will increase, and that the speed of welding, assuming that a weld is made through the entire thickness of the joint, will first increase and then decrease as the gap increases. Therefore, in this simple case there is one particular gap at which the welding of a good joint takes place at maximum speed. Not once in a thousand times does a welder know what this gap is, nor attempt to take advantage of it.

Size of Electrode

The first factor to be considered in choosing the size of electrode is the type of joint, and the next factor is the capacity of the welding equipment. Although there is a particular size of electrode that gives the best all around results for any given joint, assuming we have proper current supply, it is always possible to use electrodes smaller than the most favorable size without deteriorating the quality of the work. As far as the control of the work is concerned, it may be said that in general the smaller electrode improves the quality of the work because it forces the operator to carry the arc over all parts of the surface of the joint; whereas with a larger electrode it is possible for him to move the arc less and allow the metal to flow away from the arc and run into the joint, covering places where the arc has not actually touched, and consequently where fusion is insufficient for a good joint.

It may be taken as a fundamental principle in arc welding, that in order to get a weld, it is necessary that the deposited metal fall in the crater formed by the arc. If it rolls for any appreciable distance outside of this crater, a perfect weld will not be made.

Therefore, the choice of electrode diameter is of the greatest importance in doing good work. This choice will vary with the skill of the welder, because the more skillful the welder, the larger the electrode that he is capable of using without impairing the quality of the work.

A large electrode permits the use of a correspondingly larger current and, therefore, permits faster work than a small electrode, and the faster a weld is made, the less disturbance will result from heating. Consequently, as large an electrode should always be used as the skill of the operator will permit.

Material of the Electrode

Probably there has been more time spent on the material of which an electrode should be made than any other single item in the science of arc welding. For several years, some of the best metallurgists in the world have worked on the problem, and innumerable compositions and combinations of certain compositions and flux coverings have been evolved without appreciably furthering the art beyond what it was some 10 years ago.

Considering the arc as a miniature electric furnace, it seems plausible that a joint can be made having any desired properties providing the ingredients are properly chosen. However, in practice it does not work out so smoothly—perhaps on account of the fact that the temperature is so high and the quality of metal so small that many of the ingredients are destroyed or lost in the process of melting. At any rate, analysis of the metal in the weld proves this to be true.

According to the experience, we believe that the chemical composition of the electrode is of less importance than a uniform granular structure.

The physical properties of the electrode affect the stability of the arc more than they do the physical properties of the finished weld.

As previously stated, when I first entered the arc welding field, a company that I was with used nothing but covered electrodes, and it was not until the latter part of 1915 that I discovered that soft steel without a flux cover gave better results than the old electrodes that we had been using. From that time until the present, I have not found any electrodes that gave results in usual practice that were consistently superior to those obtainable with best quality soft steel electrodes having approximately the composition specified by the Welding Committee of the Emergency Fleet Corporation.

It is true that flux coverings have a stabilizing effect upon the arc, and where such stabilizing is necessary or desirable, as in connection with alternating current, or for overhead welding, coated electrodes are to be recommended.

What has been said up to the present time applies particularly to iron and steel. When it comes to welding bronze and other non-ferrous alloys, the choice of material in the electrode is of great importance. There is so little known of this branch of the art that those who know, consider it the best policy to hold secret the little knowledge they have.

Welding Current

For a given electrode and a given joint, the rate at which the electrode melts and deposits metal in the joint is determined by the current through the arc and nothing else. Therefore, other things being equal, the speed of welding increases with the current. However, if the speed of melting is too great, the operator will not be able to manipulate the metal fast enough to obtain uniformly good results. It must not be understood that the quality of the work increases as the current is decreased, because below a certain value in each case, the quality of the work will decrease with the speed. In fact, the quality increases with the speed of melting up to a certain point, when it falls off for the reason given above. Therefore, the choice of current must always be made as a compromise between speed and quality of the work, and must be based on actual experience under the conditions represented by the job in question.

Length of Arc

The length of the arc represents the distance which the metal melted from the electrode must travel before it is deposited in the joint. This distance contains what is known as the arc stream and in it exists the highest temperature in the arc. Therefore, the metal receives an amount of heat in its passage through the arc that depends directly upon the length of the arc. Since the metal is melted before it starts, any heat received during its passage through the arc is unnecessary. Consequently, from the standpoint of heating of the metal, the arc should always be as short as possible.

While from the standpoint of overheating and also from the standpoint of oxidation due to exposure of super-heated metal to the air, the arc should be as short as possible, the stability of the arc and the tenacity with which it persists, increases with the length up to about 25 or 30 volts. When welding on a projection or in a deep narrow gap, a much longer arc is necessary in order to be able to manipulate the metal and hold the arc, than is required when welding on a flat surface or in a shallow wide gap.

The matter of choosing the length of arc must be left in the hands of the welder. The experienced welder regulates the length of his arc according to the needs of the weld. In fact, some welders do this automatically without knowing it.

In some cases, provision is made for automatically limiting the length of the arc and in such instances, the engineer in charge can determine the maximum length to be allowed.

Method of Holding Parts

This factor while of the utmost importance is extremely difficult to generalize in production work where the same weld is made time after time. It pays well to construct special fixtures for holding the work arranged for ease of manipulation by the welder and designed to hold the parts in proper position, and furnish backing for the joint with the idea of increasing the heat dissipating capacity to a maximum degree.

In repair work, this element is one that requires experience

and natural aptitude on the part of the engineer who lays out the job. Many of the other items mentioned above may be selected over a considerable range without seriously affecting the final result. However, the holding of the work, which provides for maintenance of the relative position of the parts and for manipulation of the work during the welding operation, determines very largely the success of the job. Every other item that goes to make a good weld may be correctly chosen, but if this one item is not properly taken care of, the result will be a failure.

Welding Technic

Something was said of welding technic under the heading "Type of Joint." Further than the classification given under the former heading ,there is little more that can be said regarding the manipulation of the electrode, and in production work welding technic consists principally in the manipulation of the electrode.

In repair work, welding technic plays an entirely different part and the success of a job is many times largely dependent upon welding technic, which consists mainly in planning the method that will be employed in deposting the metal in the weld.

For instance, when welding a vertical seam, it is often desirable to fill the entire joint as the arc advances; in other cases, it is desirable to deposit a small quantity of metal on the whole length of the joint and repeat the operation a number of times which is called "multiple-string welding." It also makes a difference in which way the strings of a multiple-string weld are deposited, especially when the line of the weld is short and the thickness of the parts is relatively great. In this case, the metal should be deposited along the sides of the joint maintaining the same "V" until the last string in the middle closes it. This method of welding avoids shrinkage strains that occur when the metal is built up from the bottom of the "V" in a continually widening layer.

In some welds, it is found advisable to put in small tacks at regular intervals which is done by making a very small weld at each point. The purpose of these tacks is to prevent the heat closing the gap by expansion.

In other cases, there is danger of contraction breaking the weld before it is complete. This trouble is often overcome by putting in blocks of welding at definite intervals, choosing the putting in block of welding to withstand the maximum strain, then the rest of the weld is completed according to the multiple-string process, and if desired to get a maximum strength the heavy tacks or blocks of welding can be cut out and replaced by multiple-strings, thus relieving practically all the strain that was previously absorbed in the blocks or large tacks.

A skilled welder can manipulate the electrode in such a way as to cut, and without changing any adjustment on his welding machine he can weld. By combining the action of cutting and welding, it is possible to do some types of casting repairs that are impractical in any other way.

In many repair jobs, especially where castings are concerned, solid metal inserts can be used to advantage sometimes to reduce the volume of metal deposited and other times to increase the strength of the weld.

In such a limited space of time, it is impossible to do more than point out the principal factors that enter into the average welding problem. Up to the present time, welding has been developed by actual use. No appreciable progress has yet been attained by research and laboratory work; the reason for this is probably found in the fact that the Research Engineers work under conditions that are many times far removed from those encountered in actual practice. One of the difficulties is also due to the necessity of skill on the part of the operator, and wherever we are dependent upon a welding operators' account of what takes place, there is danger of being badly misled.

ELECTRIC ARC CUTTING AND WELDING IN THE STEEL MILL†

By C. J. Holslag*

ALTHOUGH it is the common practice in the steel industry to use gas for cutting, yet there are many places where the electric arc can be used more advantageously for cutting because of the resulting saving in cost.

One of the most outstanding examples where such a saving would result is that of rivet cutting. Here an outlay of ten or fifteen cents an hour for power and practically no other cost except one man's labor will cut from 100 to 200 rivets per hour at a cost of from a half cent to one cent each; a good average being three-quarters cents per rivet.

The arc will also cut the scrap section of the car, boiler or tank into charging size and will eat through sills, channels, or other stiffening members at a rate depending on the thickness, but at the same low cost of power.

Heavy Sections May Be Nicked and Broken

The thickness that can be economically eaten through by the arc lies below four and six inches for straight arc cutting. For heavier sections the speed of gas is greater than that of arc cutting so much so that the gas cutting is the cheaper because of the smaller labor costs. There is a method of nicking or breaking, however, where electric is more efficient than gas for any size. In any scrap pile the majority of the work is economically electric, the heavier sections may be nicked and broken, or cut through with gas.

Other uses of the arc for cutting are cobbles, hot or cold, fringe and over-flow of ingot molds and miscellaneous cutting and marking of scrap ends and mistakes in rolling, etc.

A wonderful field not yet fully developed, but being worked on industriously, is the substitution of the arc for hand chipping of seams in billets, especially those of complex alloy steels.

Length of Arc Depends on Operator's Preference

The current values necessary for these cutting operations run from 280 to 320 amperes for nicking or seaming with a special electrode giving off oxygen at the heat of the arc to 450 to 550 amperes for graphite arc nicking, 600 amperes for rivet cutting and 800 to 1,200 amperes for general and heavy cutting. The voltage of the cutting arc runs between 27 and 45, a good average being 37. An interesting feature about variations of current and voltage is that the maximum heat occurs with an arc length just longer than a "sputtering" arc. This fact combined with the fact that the radiation loss is greater with the longer arc makes it apparent to the operator that as far as maximum speed is concerned, the best arc is a reasonably long one or a reasonably short one, whichever is preferred. The chief point is to have the liberation of energy near the work to be cut up and not to waste it in heating up the atmosphere.

The Transformer Requires Little Special Attention

With the exception of nicking, heavy values of current are required and about the only piece of apparatus that can stand up under these heavy values of current and not require special attention under conditions met with around a steel mill, is a transformer. A transformer may be placed in any location, outdoors or indoors, and will survive in the dust and dirt of a steel mill.

The company I represent has spent a great deal of time and money developing a control for a special transformer, so that a short circuit would not draw too heavy current and so that the arc could be controlled at these heavy currents. Not the least of the development was the handle which must protect the operator, hold the electrode and also carry the 1,000 amperes. A small item like the use of pure graphite

†*Paper read before the American Welding Society in Pittsburgh on August* 12, 1920.

**Electric Arc Cutting and Welding Co.*

instead of carbon for electrodes almost spells the difference between success and failure.

Variety of Welding Jobs for Electric Arc

Welding by the use of the arc, with both alternating current and direct current, is pretty well-known in the steel mills and among the jobs already in use are worn wobblers padded up and by use of the carbon are hardened and smoothed at the same time; water cooled fire door repairs; rolling stock repairs and bearing breakage, wear and accidents, including special locomotive jobs such as flue welding; and miscellaneous breakage and wear, such as gear teeth, worn and broken key ways, worn armature shafts, misdrilled holes, lack of bosses, and a multitude of jobs that can be handled by a "putting on" tool.

Welding with Heavy Electrodes

A new development in arc welding as yet being applied only on heavy castings is welding directly with a metallic electrode from ⅜ inch to ¼ inch in diameter and current values of 350 to 750 amperes, with this heavy heat rate i. e., 12 to 15 K.W. at the arc, special handle, leads, etc., are necessary and so much metal is molten at a time and the temperature being gradually higher it is practically imperative to use some oxide and nitrode restraining flux. Because of the great majority of this heavy work being hole filling and speed being generally one of the results desired, the use of a slag coated electrode where metal must be put down in layers, each layer being chipped off before another layer is applied, is out of the question, although this type of electrode has the effect desired of protecting the molten metal from the air for straightening head work such as welding a calking edge. An electrode which protects the molten metal from oxidation and nitrogenization by chemical action i. e., fluxing action passing off the oxides and nitrides as a gas naturally fulfills better the protecting action necessary without brushing or chipping being necessary. Bare wire welding at these current values is out of the question if results reacting to the benefit of arc welding as a whole are desired.

Heat Energy Flow in Arc Welding

In discussing alternating current and direct current cutting and welding, it is often said that because the temperature of the positive electrode is higher, that special work can be done with direct current apparatus. However, I would call your attention to the fact that in either cutting or welding the tool electrode is always much smaller than the work electrode, and no one can conceive of the heat dividing equally between this one small area and the infinitely larger one of the work, so that in alternating current or direct current the heat is absorbed to the extent of over 90 per cent by the work, neglecting the air losses of a long arc. In the case of alternating current, although the current and voltage are reciprocating, the heat energy flow is practically in one direction, that is, to the work.

MEETING OF CHICAGO SECTION.

The September meeting of the American Welding Society, Chicago Section, was held in the rooms of the Western Society of Engineers, Tuesday evening, September 14th. The speakers for the evening were Mr. S. W. Miller and Mr. E. Wanamaker. Mr. Miller, proprietor of the Rochester Welding Works, Rochester, N. Y., is one of America's leading authorities on sound welds and how to make them. His paper was entitled "Testing Welds." Mr. Wanamaker, electrical engineer, Rock Island Lines, is a recognized authority on autogenous welding, particularly railroad welding. The subject of his paper was "Autogenous Welding on Railroads."

LICENSING OF WELDERS

Editor: Surely a man claiming to be a welder can have no objection to an examination as to his ability and his fitness to hold the title. Such an examination will indeed help him if he is a welder. It is only the "plasterers" who would suffer. Is there any valid reason why they should be tolerated? Surely we have enough honest criticism to contend with, and the sooner these plasterers are found out and driven from the industry the better it will be for all concerned, plasterers included.

Stop and think what a weld really means—safety, if it is a weld; loss of property, life or limb to perhaps scores of people, if it is a plaster.

Another thing that hurts the cause of welding is that a thousand good jobs go unnoticed while one failure is advertised far and wide. By all means let us be licensed! Let us have a theoretical examination and a practical demonstration of what we can or cannot do. I have seen welds that looked and sounded perfect but when broken under pressure showed very grave flaws, and those by men who were considered expert.

Not only would I advocate a license to be granted only on the passing of a theoretical and practical examination, but I would strongly advocate a re-examination at least every two years.

In regard to charging a fee, my suggestion would be that the applicant post a sufficient sum to cover the expense of the examination, this sum to be returned if the examination be successfully passed, and forfeited in case of failure. All welds should be stencilled for identification. To insure an impartial examination I would suggest that the law-making powers delegate a committee from the American Welding Society or other kindred organizations, to be the examiners.

I feel sure that should the above or similar regulations be put into effect exhibits like those in Mr. Pack's office will be a thing of the past. It would be impossible for a real welder to do such a job as those described. It would also tend to make the welder a little more cautious. He would insist on his work being properly prepared and cleaned. A man takes a chance once in a while to hold his job, but when he knows that if it proves faulty his livelihood will be gone for a certain time, he will be more apt to insist on a right start.

Henry F. Waas.

WHAT IS THE BIG TROUBLE WITH ARC WELDING PRACTICE.

The big thought on this subject seems to be: ELECTROLYSIS.

Let's give old electrolysis the day in court every man is said to be entitled to.

The electrode is certainly shocked to death or something less than fatally, but how much less and why—there's the burning question.

Let's just cremate a few sticks, and, when the results of the three instances are congealed into the semblance of sound welds, then let's do a few tricks with them—hence:

1. Break the weld—raw, and look for signs of electrolysis.
2. Heat and hammer the weld, while hot, allow to become cold, without quenching—then break and note the difference.
3. Heat to 1,450 degrees Fahr. and allow to cool in the ordinary manner—then inspect.

Everybody knows everything about preheating—who knows anything about curing burned steel?

My personal suggestion as to the answer for curing all electric welds is to heat to a uniform 1,100 degrees Fahr., then play the hose freely 'til cold—then all the electrolysis goes hiding, and the tensile, elastic, reduction of area, etc., all gets much nicer and everybody smiles.

The Welding Wire Man

GENERAL WELDING & EQUIPMENT CO.

G W E C

74 BROOKLINE AVENUE, BOSTON, MASS

IMPORTANT:

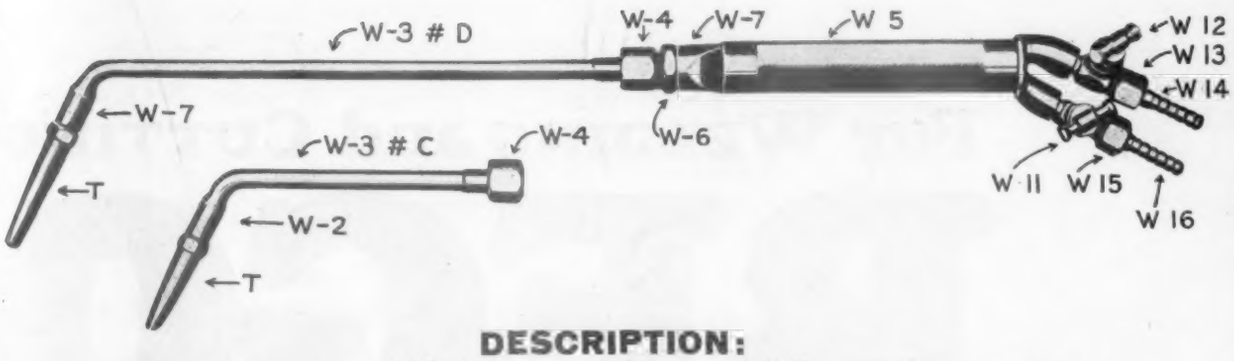
THE GENERAL WELDING & EQUIPMENT CO. HAVE MOVED THEIR OFFICES AND DEMONSTRATION ROOMS INTO THEIR NEW AND CONSIDERABLY ENLARGED FIREPROOF QUARTERS

74 BROOKLINE AVE., BOSTON, MASS.

■ ■ ■ ■

STANDARD WELDING TORCH

STYLE W



DESCRIPTION:

THE CONSTRUCTION OF OUR WELDING TORCH IS SHOWN IN LINE CUT. A VERY CAREFULLY DESIGNED MIXING CHAMBER (W6) MIXES THE OXYGEN COMING THROUGH THE CENTER HOLE INTO WHICH THE ACETYLENE IS SPRAYED IN THROUGH A NUMBER OF FINE SIDE HOLES THUS PRODUCING A PERFECT MIXTURE.

HANDLE (W5) IS SCREWED ONTO THE TORCH BASE AND CAN EASILY BE REMOVED BY LOOSENING A SET SCREW. FOUR LARGE VENT HOLES ARE DRILLED THROUGH THE BASE AND THE MIXING CHAMBER CASTING SO AS TO PROCURE A PERFECT VENTILATION. THE THREAD FOR ACETYLENE IS ¼" PIPE AND FOR THE OXYGEN INLET ⅜" PIPE, SO THAT THE HOSE CANNOT BE CONNECTED WRONG.

THE MIXING CHAMBER (W6) IS FAR REMOVED FROM THE TIP END OR HEAT ZONE. THE UNMIXED ACETYLENE, THEREFORE, CANNOT GET OVERHEATED AND CAUSE FLASH-BACKS THROUGH DECOMPOSING, NOR CAN IT GET SO HOT AS TO VARY IN EXPANSION AND CAUSE FLUCTUATIONS OF THE MIXTURE, THUS CHANGING THE CHARACTER OF THE FLAME. THE FLAME ONCE SET NEUTRAL WILL STAY NEUTRAL REGARDLESS OF THE VARYING HEAT AT THE TIP END AND WILL NOT FLASH.

THE STANDARD WELDING TORCH IS SOLD WITH TWO EXTENSIONS (W3-C AND W3-D) SO AS TO HAVE EITHER A 16" LONG TORCH OR A 22" LONG ONE, GIVING YOU PRACTICALLY TWO TORCHES OF DIFFERENT LENGTHS. A THIRD EXTENSION (W3-F) MAY BE SUPPLIED SO AS TO MAKE THE TORCH 30" OVER ALL. NINE INTERCHANGEABLE TIPS (T1-T9) GO WITH EACH TORCH.

The Best Rego demonstrator is a Rego Torch

For WELDING and CUTTING

REGO

Master of Metals

THE BASTIAN B

West Austin Avenue at LaSalle

Every fundamental invention proceeds from complexity to simplicity. Sometimes by slow degrees--sometimes by a stroke of genius that changes its application almost over night.

The welding torch is no exception to this rule. Only yesterday welding was done by apparatus difficult to handle; results varied, the best operators failed from time to time; the welding torch was an uncertain quantity.

Then the inventor stepped in.

At one stroke the welding torch was revolutionized. Flashback was eliminated—a smooth flame took the harsh, oxidizing heat that spoiled so many welds.

The REGO torch accomplished this by an inventive feat hitherto called impossible by the foremost welding authorities! By making a flame of *low, balanced* pressures of oxygen and acetylene, with the acetylene pressure *slightly greater*.

The torch is so simplified by this fundamental invention that an experienced welder needs no instruction in its use.

A REGO salesman simply puts the torch in the hands of the welder and says, "Go to it!" And he *welds* as never before—and as though he had used a REGO all his life.

Write for the REGO booklet, "A New Principle in Welding and Cutting Apparatus." It tells the story in detail. Catalog also upon request.

B SSING COMPANY

lle eet Chicago

Gas Welded Bonds Improve Track Circuits*

More Rail Protection, Greater Efficiency, Fewer Number of Sections and a Reduction in Broken Bonds

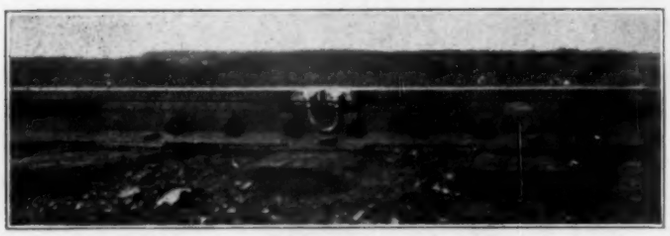
By E. W. Kolb†

Welding a Bond in from Three to Four Minutes by the Use of the Gas Welding Outfit

IT has been the desire of every signalman, for a considerable period of time, to obtain better bonding. Just why the welded bond, the bond that will solve many of the track circuit difficulties, has been cast aside is hard to understand. Electric railways have been forced to use bonds of this type in order to get enough power through the rails to operate their traffic. The application of such bonding has postponed the installation of heavy feeders, and the interest on this delayed investment has made a large saving in addition to the energy saved by its use.

Present Type of Bonding for Track Circuits

Considering the present method and material used for bonding joints in track circuits, it is realized that copper wire bonds crystallize on account of the excessive vibration; copper clad wire bonds rust out and do not last much



A Joint Bonded by Means of the Gas Welding Process

longer than steel or pure iron bonds; and the resistance of both copper clad and iron is too high. With the present method the troublesome channel pin is used and a long bond wire extends around the joint, making it absolutely impossible to detect a broken rail in the joint. Under this condition with angle bars 26 inches long there are 800 feet of track in every mile that absolutely has no broken rail

*Reproduced from the Railway Signal Engineer by courtesy of the publishers.

†Signal Engineer, Buffalo, Rochester & Pittsburgh, Rochester, N. Y.

Making Electrical Test of Channel Pin Bonding

protection. This figure is reduced to 54 feet with the welded bond, under which condition a break would have to occur so near the end of the rail that a train could run safely over the break at high speed.

Welded Bonds for Track Circuits

In order to demonstrate the possibilities of welded bonds, a track circuit having high resistance bonding was selected. This circuit is on a branch line of the Buffalo, Rochester & Pittsburgh where the traffic is light. In October and December, 1910, this stretch of track was relaid with 80 lb. old rail and joints taken from the main line. The ballast consists of cinders, more or less in contact with the rail. Elec-

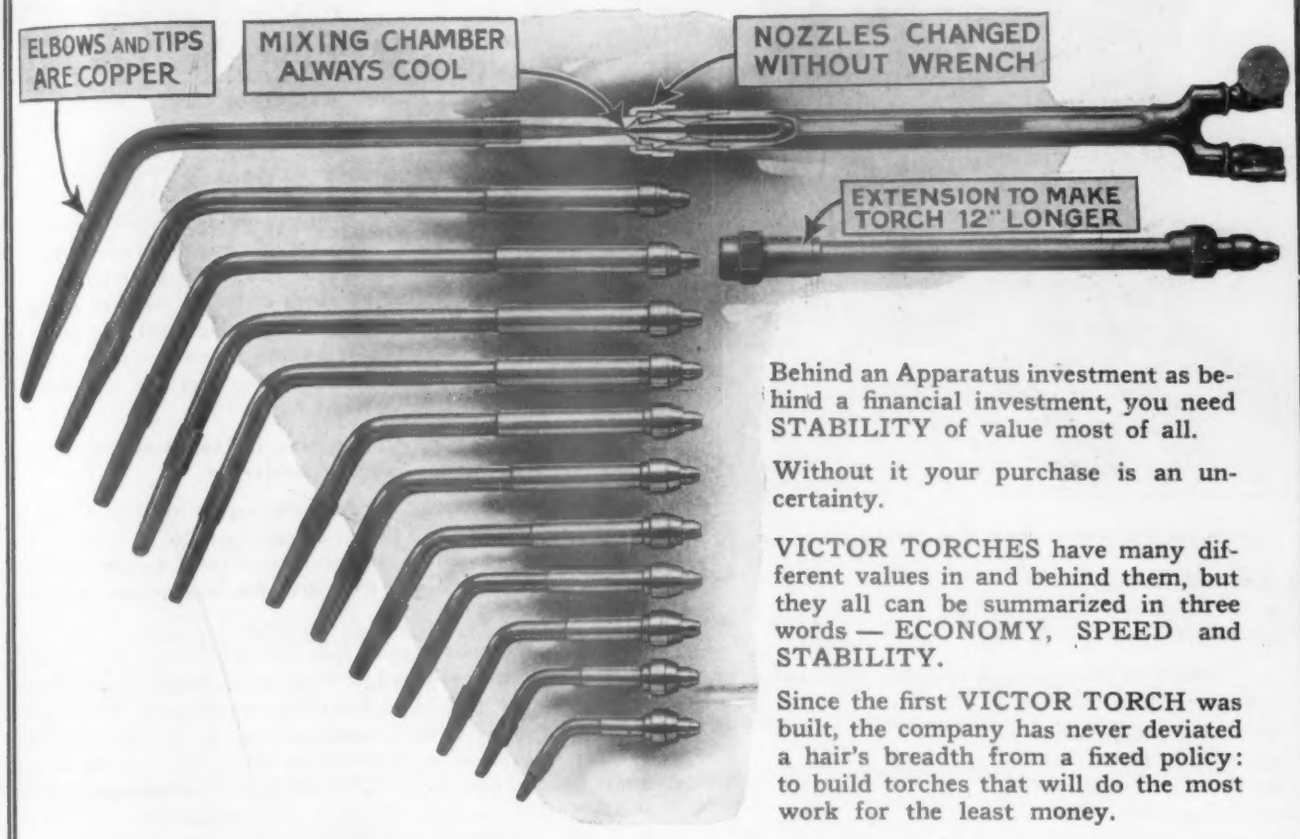
Welding Bonds by Means of Gas Outfit Carried on Motor Car

trical tests were first made to determine the condition of channel pin bonding. Then the section was rebonded with gas welded bonds and another set of electrical tests were made. The complete report on those tests follow:

Name of railroad—Buffalo, Rochester & Pittsburgh.
Location of section bonded—Silver Lake, N. Y.
Weight of rail—80 lbs. Section—LI&S 595. Length—30 ft.
Type of joint—F. P. Length of angle bar—No. six bolt.
Condition of joints—Good. Kind of ties—Plain, 2 per cent creosoted.
Kind of ballast—Cinder.
Condition of ballast—60 per cent touching bottom of rail.
Condition of roadbed—Good; dry, well drained.
Length of bonded section—2,376 ft.
Method of bonding—Channel pin. Length of bonding wires—Two 54-in. galvanized No. 8.
Kind of batteries used—Caustic soda.
Number of cells used—Three in multiple.
Breakage of rail on section for last period—None.
Show percentage of breakage in joint—None.
Number of trains over track per day—14. Approximate number of cars—61.

VICTOR
TRADE MARK
Metal
Cutting and Welding
Equipment

Victor Torches First in Economy, Speed and Stability


ELBOWS AND TIPS ARE COPPER
MIXING CHAMBER ALWAYS COOL
NOZZLES CHANGED WITHOUT WRENCH
EXTENSION TO MAKE TORCH 12" LONGER

Behind an Apparatus investment as behind a financial investment, you need STABILITY of value most of all.

Without it your purchase is an uncertainty.

VICTOR TORCHES have many different values in and behind them, but they all can be summarized in three words — ECONOMY, SPEED and STABILITY.

Since the first VICTOR TORCH was built, the company has never deviated a hair's breadth from a fixed policy: to build torches that will do the most work for the least money.

This has been fully proven within the last four years when speed counted more than ever, and tools were strained to their utmost capacity, when VICTOR TORCHES stood up and kept going day after day, and year after year, in all kinds of service and under all sorts of operating conditions. Records have been broken to the extent that similar work is accomplished in one-half the time, and one-half the gases as previously done. This is possible because VICTOR TORCHES mix their gases properly, allow the flame to be increased to ultimate power without blowing, and when needed the flame can be reduced to a tiny tongue of fire, and still they do not backfire.

The high regard in which VICTOR TORCHES are held by all their users is but the inevitable result of their intrinsic qualities, as demonstrated in actual service. To have produced a torch which has contributed in so large a measure to the perfection of the welding art is, indeed, an achievement, of which we are justly proud.

Victor Oxy-Acetylene Equipment Co.

18 North Jefferson St., Chicago, Ill.
766 Glisan St., Portland, Ore.

68 Grand River Ave., Detroit, Mich.
Pittsburgh, Pa.

884 Folsom St., San Francisco, Calif.
Erie, Pa.

Electrical Tests of Chanel Pin Bonding

Date—April 5, 1920.
Voltage at battery terminals—0.68.
Voltage across rails at battery end—0.60. Current to rail, normal—0.218.
Voltage across rails at relay end—0.48.
Voltage across relay terminals—0.47.
Current through relay—0.125.

How the Gas Welded Bond Looks When Completed

Indicated rail resistance—0.70
Indicated ballact resistance—5.8.
Foreign current conditions—None.

Electrical Tests of Gas Welding Bonding

Date—April 14, 1920.
Voltage at battery terminals—0.7.
Voltage across rails at battery end—.48
Current to rail, normal—0.180.
Voltage across rails, relay end—0.48.
Voltage across relay terminals—0.47.
Current through relay—0.123.
Indicated rail resistance—0.07.
Indicated ballast resistance—9.3.
Foreign current conditions—None.
Relay leads—Copper. No. 8 B&S gage. Length—32 ft.
Relay rated pick-up—0.078.
Drop-away—0.036. Resistance—4 ohm.
Relay make—GRS. Type—Wall. No. contacts—4.
External resistance—0.35 ohms before rebonding; 105 ohms after rebonding.

Joint Test

Tests were made on joints beginning at positive battery end. One hundred and forty-five were bonded but the results shown on the first 26 are typical of all. A Weston millivoltmeter was used in testing and the drop across the joint with no bond frequently went above the scale of .200 volt.

Joint No.	Old Bond	No Bond	New Bond	Physical condition of bond
1	.0005	.200 +	+	
2	.0005	.200 +	+	
3	.0002	.001	.0001	
4	.0002	.0002	.0001	
5	.0008	.180 +	+	
6	.0005	.200 +	+	
7	.0002	.114	+	
8	.0002	.0002	.0001	
9	.0006	.030	.0001	
10	.0001	.0001	.0001	
11	.0006	.110	+	
12	.0003	.0003	.0001	
13	.0006	.200 +	.0001	Ball of rail cracked
14	.0004	.042	.0001	
15	.0008	.200 +	.0001	
16	.0003	.200 +	.0001	
17	.0002	.102	.0001	
18	.0006	.200 +	+	
19	.0008	.0088	+	
20	.0001	.0001	+	
21	.0006	.036	+	
22	.0001	.0001	.0001	
23	.0001	.0001	.0001	
24	.0002	.050	.0001	
25	.0004	.135	.0001	
26	.002	.002	.0001	

The work of rebonding with gas welded bonds required 12 hours and 50 minutes. The actual time for each bond, including the moving of apparatus and traffic interruptions was 5.3 minutes. The actual numbers of bonds installed per hour was 11.6. The maximum number of bonds installed per hour by O-B welder was 16 and by the railroad welder was 12. The total amount of flux rod required was 19.8 lbs., and the actual flux rod per bond was 2.2 oz.

The flux rod consumption was increased slightly on account of training the railroad welder.

The cost of flux rod per 100 bonds on a basis of 2 ozs. per bond or a total of 12.5 lbs. at 50 cents per lb. is $6.25.

The total oxygen consumption amounted to 280 cu. ft. or 1.9 cu. ft. per bond and for 100 bonds the consumption was 190 cu. ft.

The oxygen consumption was somewhat higher on account of training the railroad welder who required about one minute longer per bond than the experienced welder who installed the first bond using 1.6 cu. ft. of oxygen. The average consumption is therefore placed at 1.75 cu. ft. per bond for the cost data. The actual cost of oxygen per 100 bonds on the basis of 1.75 cu. ft. per bond at $1.75 per cu. ft. is $3.06. The actual acetylene consumption was 330 cu. ft., or 2.3 cu. ft. per bond and for 100 bonds the consumption was 230 cu. ft. The acetylene consumption was somewhat higher on account of training the railroad welder who required as stated above one minute longer per bond. The experienced welder used 1.7 cu. ft. of acetylene for installing the first bond, so that the average consumption is therefore placed at 1.85 cu. ft. per bond for cost data. The actual cost of acetylene per 100 bonds on the basis of 1.85 cu. ft. per bond at $2.00 per 100 cu. ft. is $3.70.

The actual cost of labor on the basis of an experimental installation requiring 2½ eight hour days to install 145 bonds, employing a welder at 54 cents an hour, and a helper at 49 cents per hour, shows that the labor per 100 bonds was $14.10.

The actual cost of labor on the basis of actual installation time, allowing 1.5 hours per day in getting to the job, is as follows: Welder at $0.54, and a helper at $0.49 working 8 hours and installing 11.6 bonds per hour was $10.42. For a 10-hour day, time and a half for over-time, the cost would be $11.45.

The actual total cost per 100 bonds—labor and material the present market rate is as follows:

The WIEDERWAX PREHEATER

For OXY-ACETYLENE WELDING IN RAILROAD SHOPS

Welding Units in Railroad Shops Are Not Complete without the WIEDERWAX PREHEATER

WHY ?

Showing variety of locomotive repair work done on the Wiederwax Pre-Heater

Because—It is the latest, most scientific development in connection with Oxy-Acetylene Welding, and is always ready for instant use;

Because—It is the most economical and practical device in use today;

Because—Its upkeep and operating cost is extremely low;

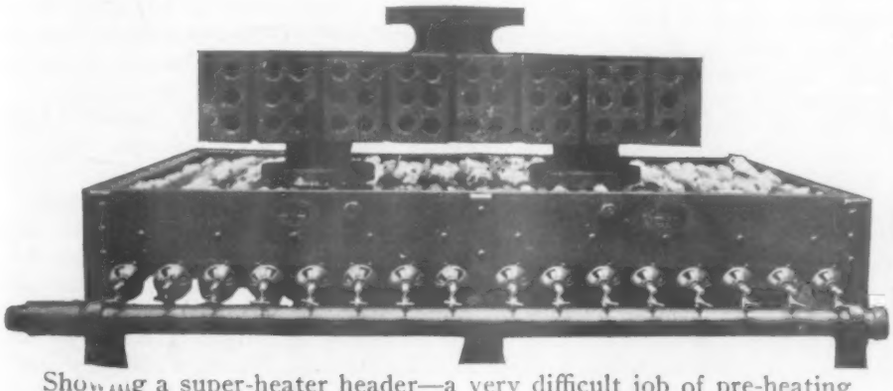
Because—For successful and economical Welding of cast iron and other heavy welding work it is absolutely necessary to preheat evenly to get equal expansion and to retain equal expansion during Welding, as well as to cool evenly;

Because—The WIEDERWAX PREHEATER is absolutely guaranteed to do this, and more;

Because—It will Increase Welding Production and Reduce Time and Cost;

Because—The WIEDERWAX PREHEATER entirely eliminates the use of charcoal and all other crude methods of preheating;

Because—The WIEDERWAX PREHEATER will keep your shop clean and free from undesirable fumes and smoke.



Showing a super-heater header—a very difficult job of pre-heating accomplished successfully on the Wiederwax Pre-Heater.

For Further Information Write for Our Railroad Booklet

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Bonds No. 1, B. & S. capacity—7 in. length per 100	$20.00
Flux rod, 1/8 in. diameter gas weld—Cat. No. 12630 at $0.50 per lb., 2 oz. per bond	6.25
Oxygen at $1.75 per cu. ft. (per bond $.0175) per 100 bonds	3.06
Acetylene at $1.85 per cu. ft. (per bond $0.02) per 100 bonds	3.70
Labor, 10-hour day (as noted above)	11.45
Total cost per 100 bonds	$44.46

The railroad welder, Mr. Moffatt of the signal department, progressed very nicely in bond welding. Timing his work by hour periods showed that he installed 12 bonds each hour. The actual welding time was four minutes per bond, while the actual welding time for an experienced operator was three minutes; that is, 15 or 16 bonds per hour can be installed on straight away work without traffic interruption.

It will be noted that the rail resistance has been reduced from .7 ohm to .07 ohm and that the voltage at the relay end of the circuit is the same as at the battery end as near as could be measured with a model 56 Weston voltmeter. Practically there should be a drop of .01 or .02 volt, but allowing for enthusiasm it is difficult to conceive even an approximation of such results by using the ordinary bonding. The bonds themselves have a calculated resistance of about .0105 ohm and that of the rail is .0603 or a total of .0708. But from measurement the actual bond and rail resistance is .07, practically the same as the "rail only" resistance.

We may now determine what can be gained or saved by this type of bonding.

Current Consumption

In this track circuit 0.038 amperes was saved, which in renewals amounts to $1.65 per year or the interest on $27.54 capitalized at 6 per cent. As the bonding of this section cost more than that amount, the saving in current alone is not sufficient to pay for renewing the bonding on this account. If it were necessary for any other reason to renew the bonding, then only the additional cost of the welded bonds should be figured over the ordinary bond wires. At present prices of material and labor standard bonding costs about 30 cents per joint. Welded bonding costs about 45 cents per joint, an increase of 15 cents per joint for 145 joints or an increase of $21.75, from which it appears that the saving in battery current alone is enough to more than offset the additional cost of welded bonding over ordinary bonding.

There is also the fact that the voltage drop in the rails is so slight that it may be possible to use longer track circuits. The present maximum length of track circuit is 3,500 ft. for four ohm relays, with the result that a very large majority are much less than this. Another thought is that since the voltage drop in the circuit is so little it may be satisfactory to use a lower voltage, resulting in a less amount of current lost in ballast leakage. This would permit the use of a higher external resistance between the battery and rails. The higher this resistance is, the higher the efficiency of the circuit, that is, the ratio of normal current to wet weather current and the ratio of the normal current to the shunted track circuit current. It may be possible by using a lower resistance relay to make all or a large percentage of track sections a block long, eliminating a part or all of the track cuts and line wire. These thoughts are only suggested possibilities but this method of bonding is manifestly so superior that there seems to be no reason to continue the present unsatisfactory method. It is hoped that other trial installations will be made and the matter thoroughly studied from every standpoint, that we may learn the objectionable features of welded bonding, although it now seems to have none. We will then be able to judge wisely as to what extent it should be used.

NEW GENERAL MANAGER FOR IMPERIAL BRASS

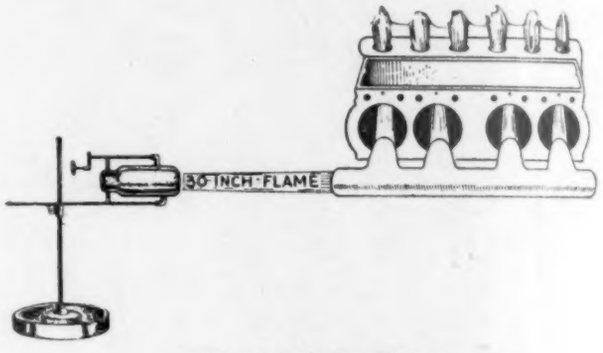
William A. Leonard, of Chicago, has been elected vice-president and general manager of the Imperial Brass Manufacturing Company of that city, well known makers of Imperial oxy-acetylene welding equipment, Watrous plumbing supplies, and a general line of automobile accessories and brasswork.

Until recently Mr. Leonard was associated with Belding Brothers & Company, of Chicago and New York, as organization and sales promotion manager.

This election completes the sales organization of the Imperial Brass Manufacturing Company, which ranks as one of the leading brass manufacturing concerns of the middle west.

PREHEATING CYLINDERS.

A circular published by the H. A. Smock Co., Indianapolis, describes a simple and effective method of preheating cylinders for welding. Lay a manifold on the bench, point



Preheats Cylinders Evenly

center to each cylinder and place nose of torch against manifold. When cylinders quit smoking, start your weld. When done, let the preheating torch gradually draw down the heat, cover with asbestos and turn down the torch. Your cylinders are not even red and when cool are in perfect alignment and as slick as ever.

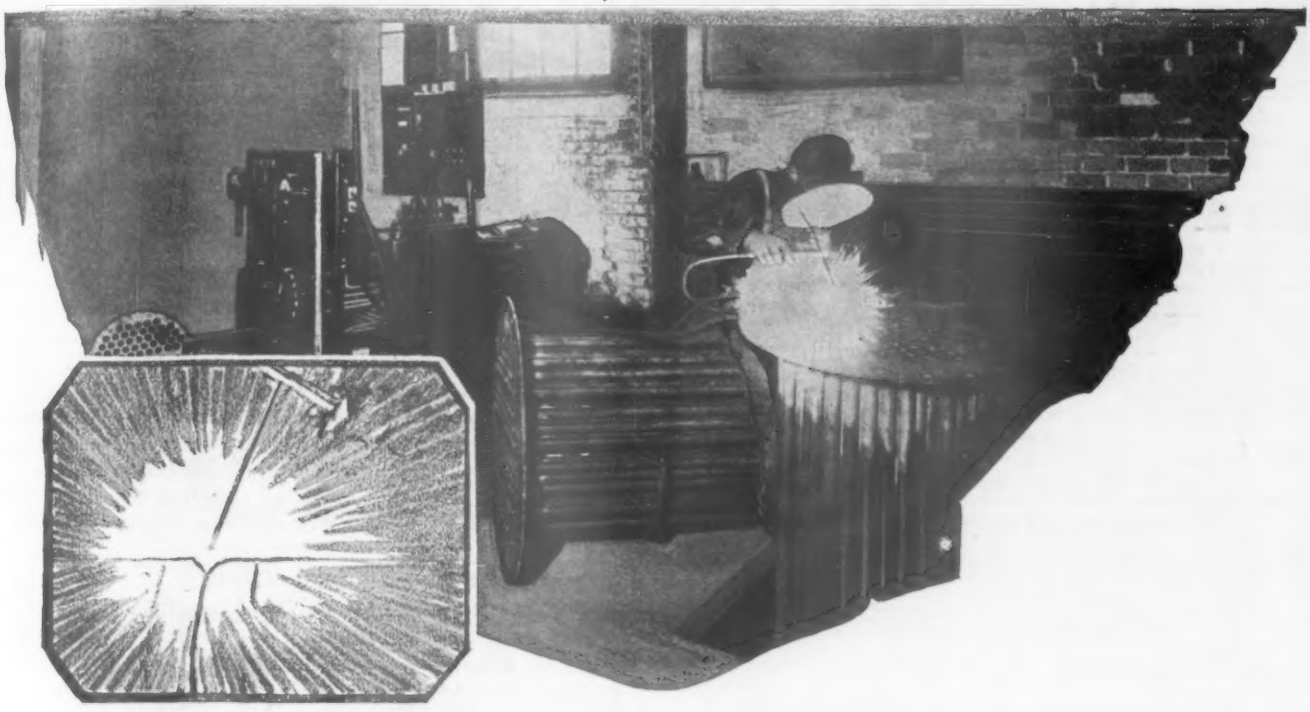
"WILLSON GOGGLES" A SEPARATE INDUSTRY

Goggles as a "side line" have been popular with various manufacturing plants, but it remained for Willson Goggles, Inc., of Reading, Pa., to demonstrate that one plant of some size can operate successfully by making goggles exclusively. Established in 1870, just fifty years ago, as a "spectacle factory" in a little building on the corner of the present site, the Willson organization has grown so rapidly that it won it the war position of eye protection contractors to the United States and British governments, and the permanent position of eye-protection contractors to many plants, railroads and other industrials. Last winter, the firm name was changed from T. A. Willson & Co., Inc., to Willson Goggles, Inc. Willson Goggles, Inc., claim the largest plant in the world devoted to the exclusive manufacture of goggles.

A COMPLETE LINE OF SOLDERS.

A leaflet prepared by the Rohde Laboratory Supply Co., announces a complete line of solders for the metal industries. A1-Solder, for work on sheet aluminum, lap joints and general repairs, is used alone or with auxiliary metal fillers which come in six different grades to meet the varied demands of general and special repair work. The line also includes aluminum filler rods and fluxes, cast iron solder, a solder for general soldering work, a solder for work on German silver, and a Sterling silver solder.

The manufacturer who says, "My business is not large enough for such an improvement," can generally say the same thing ten years hence



The Electric Needle that Knits Metals

If any manufacturer, who produces some article which requires a joining of metal parts, could look through the shield and actually see what takes place in electric arc welding, he would soon see why this process is a factor in improving production.

He would see a thin wire being thoroughly made a part of the metal itself, through the fusing power of a white hot electric arc. He would see a crevice being gradually filled with molten metal which not only closes the gap itself, but actually becomes a part of the metal on either side. And he would realize that the electric arc is as much a manufacturing asset in the production of metal products as it is in the fabrication of ships or the repair of castings and forgings.

The General Electric Company has foreseen the wide possibilities of electric welding in all industries where metals are used, and has developed arc welding apparatus for a great variety of uses. Whether a small portable type which may be taken to the work, or an outfit which allows a dozen welders to work at one time in a special department, there is G-E welding equipment now available for prompt delivery.

Select the right equipment for the work—and a welder who knows his business

Bulletins describing G-E Welding Equipment and the G-E Welding School sent on request to our nearest office

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

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Let's Have The Evidence.

WITH the right kind of co-operation from the trade good results will come from the present campaign of the American Welding Society, Chicago Section, to secure more favorable consideration for the welding process as applied to pressure tanks. Anyone who has had experience in welding pressure tanks can help the cause appreciably and at practically no expense by sending to the Development Committee, of the American Welding Society, 608 South Dearborn Street, Chicago, a complete reply to the questionnaire that has been sent to the trade in the form of a four-page circular. The committee needs this evidence at an early date so that it may be properly compiled for presentation to the Boiler Code Committee of the American Society of Mechanical Engineers in December. It is certain that fusion welding is entitled to a higher rating than it will get unless the claims that can justly be made for it are well supported by the evidence that is being sought.

Try This on Your Welders.

LAY out a small job of welding. Light your torch and then call in one of your welders. Hand him the lighted torch and tell him to go ahead and weld up the job. Chances are the first thing he will do is to change the flame. Proceed in the same way with your other welders and observe how many of them will be content to accept the other fellow's flame adjustment as being correct. There can be but one correct adjustment, so why should the original flame adjustment be changed? Is it because of faulty vision, or a lack of knowledge as to exactly what a correct flame should be?

Success Is Made Up Of Little Things.

MR H. J. HUGHES has written an article on "Welding a Locomotive Cylinder" for this number of *The Welding Engineer* in which he states: "While waiting for the cylinder to heat everything was prepared for the job, such as gas, oxygen and fuel, and tongs to handle the brick, to avoid having to stop and look up the things which would be needed after the welding started." How many welds have been ruined by men who were expert with the torch, but who did not think far enough ahead to make arrangements to carry on their work without interruption? Or, how much time is lost in the average welding shop because all the wrenches have been misplaced and nobody ever has time to put up a little shelf for the special purpose of parking the wrenches when not in use? Welding is such a comparatively young industry that the little things have not been given careful enough attention. In the old days a master carpenter would have a young fit if he saw an apprentice misusing a plane, a saw, or a chisel; the welding foreman ought to feel the same way when he notices that the young welder is careless about letting the welding hose get near hot metal. There is a generous list of these "little things," and it pays to be alert in watching for them.

Another Phase of the Human Element

FREQUENT reference has been made to the human element in welding, but we have not had much mention of the importance of good vision to the welder's efficiency. Our attention was recently called to the experience of an old timer who traced one welder's failures to defective eyesight. In this case the workman could not see well enough to know that his welding rod was not in contact with the puddle. Color blindness is another defect that may lead to trouble. Extreme nervousness, causing unsteady hands, should also be guarded against in looking over a prospective welder. The art is not too hard to learn for the workman of ordinary intelligence, nor is it extremely hard on his constitution, but some of its requirements are very exact, so exact that the slightest deviation means imperfect workmanship. This is

2 hours

Here's the story in a Nut Shell

THE TELEPHONE RINGS in MacMulkins' repair shop. He is asked if it is possible to repair a broken spur gear. MacMulkins says, "Sure it is".

Puts on his hat, slips a cylinder of Prest-O-Lite and his oxy-acetylene welding apparatus on his emergency truck.

In two hours Mac. returns with $32.50 more in his wallet than he left with and the satisfaction of having another booster for the efficient way MacMulkins repairs *anything.*

In this particular case, several days of valuable time were saved and a casting made new. A saving of several hundred dollars at least.

The use of Prest-O-Lite, the Universal Gas with the Universal Service, in any metal working shop assures extreme portability of the oxy-acetylene process of welding.

Write us about the Nation-Wide Service Plan of Prest-O-Lite.

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particularly true of electric arc welding. A short time ago an American contemporary published an article relating to places in American industry for disabled soldiers, and used as an example the electric welding machine that can be operated by men who are totally blind. This is interesting, but it is not welding. A man needs to have all his faculties working and under control to produce good welds, and the welding foreman will do well to give applicants for jobs a careful scrutiny with this thought in mind.

If There Is a Business Slump.

SOME folks predict a business slump. They say we can't go on raising each other's hands much longer. We don't look for a serious industrial depression—we can't have one so long as we are so short of labor. But if it comes, the welding industry will be one of the very last industries to be seriously affected.

You don't buy welding equipment because you have surplus money to spend. You buy it because you *don't want to spend money.* Its purchase is an economy measure—thrifty, in fact. Any welder could complete our argument—it's useless for us to continue. We think the welding trade is "sitting pretty."

SHOULD WELDERS BE LICENSED?

Editor:—The letter written by Mr. R. H. Anderson in the August number of *The Welding Engineer* sounds good to me; as he says, it gives us all something to think about.

I think every welder, whether gas or electric, should come to the front with his suggestions, and not hang back as if he were afraid of criticism. As Mr. Anderson says, it certainly is disgusting to hear an outsider run down the welding craft, and worst of all to hear the foreman or mastermechanic or superintendent of some railroad company knocking the welding craft. Sometimes I don't wonder at them, though, when I see some of the car bolsters and car transoms that come in for repairs, broken where they were welded before or looking as if they had been stuck together with chewing gum or putty. This is the kind of work that welders want to do away with.

My suggestion would be to get up a questionnaire and have each welder who makes application fill in the questions and also demonstrate on different metals, to determine his ability. This work should be witnessed by his foreman or some other competent person. All his work should be stamped with his initials and registered in the questionnaire. A list of applicants might be published in *The Welding Engineer* each month, and the questionnaires sworn to before a notary public.

Yours for welding,

E. F. Ballinger.

SIMPLIFIED WELDING

By W. W. Palmer*

WHEN using the ordinary round metal electrode in metallic-arc welding the arc stream is approximately round in cross-section. At the place where the arc strikes the parent metal there is a small, white-hot crater. Only that part of the rapidly fusing electrode which strikes this molten spot on the parent metal becomes fused with that metal. Consequently it is necessary for the welder to move the arc and its molten crater over every part of the surfaces to be fused.

For instance—suppose the two plates shown in Fig. 1 are to be welded. The welder establishes his arc at some point as at a and holds it there just long enough to get his crater established, when he moves it on to b. After getting a good crater at b he moves it on to c, d, e, f, g, etc., going from one plate to another and attempting to keep them both at a fusing temperature.

The welder must be skilled to perform the following operations:

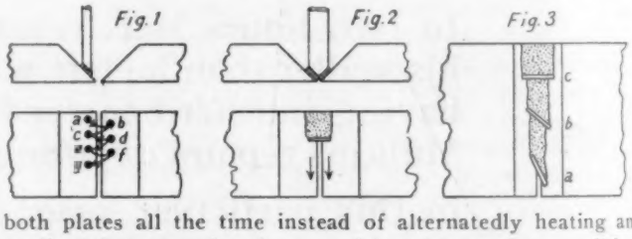
1. Feed the electrode into the arc at the same speed that it is melted.
2. Move from plate to plate, with regular swing, in order to fuse both parent members equally.
3. Move the arc along the direction of the seam as the welding progresses.
4. Dip the electrode toward the bottom of the V each time it crosses over, in order to properly fuse the bottom of the seam.

In order to simplify this complicated process the following method has been evolved: Instead of a round electrode, round arc, and round crater a flat wire, flat arc, and an oblong crater are used. (See Fig. 2.)

By holding the wire in the position shown the arc burns simultaneously completely across the face of the ribbon and on both parent plates; consequently the electrode is not wiggled from plate to plate, but is fed straight into the arc and the arc is gradually lead in the straight path shown by the arrows in Figure 2.

The arc length is automatically kept the same completely across the surface of the flat wire, regardless of the shape or contour of the surface being worked upon. The explanation for this phenomenon is as follows: Suppose, through eccentric manipulation or irregular parent surface, the electrode should come closer to the work at one point than at others. Then the resistance of the current path at that point is less than at others, thereby causing a rush of current to that point which quickly fuses away the thin electrode in that vicinity. This feature is clearly seen while watching the arc in operation.

This results in smoother work and easier welding since the chances of "freezing" are minimized. The fact that only two motions are required as against four with the round electrode enables the operator to make a smoother deposit with less effort. The fact that the arc is maintained on



both plates all the time instead of alternatedly heating and cooling them permits the use of less heat, other conditions remaining the same. This charactertistic also makes it more certain that both plate surfaces are fused properly.

When correct currents are used the rate of metal deposition is proportional to the cross-sectional area of the electrode used. Yet, where several runs are to be made, lack of working space prevents the use of a large round electrode for the first runs. Consequently two or more sizes are used with the sacrifice of speed when using the smaller rods. In such cases the flat electrodes are used as shown in Figure 3. The rod is moved straight down the seam as before. Excellent fusion as well as rapid deposition is obtained. This is especially applicable to the first runs of a lap joint where the majority of the strength of the weld is obtained. As the bottom of the seam is filled, and more working space is obtained thereby, the succeeding rounds are made with the rod in the positions shown in b, c, and d (Fig. 3) respectively.

Besides affording greater speeds for the bottom runs it is possible for a welder, when on such work as ship work, to carry only one size of electrode instead of the usual ⅛ inch and ¼ inch sizes. It is also a fact that less chipping or planing is required when preparing heavy work for welding since the electrode used edgewise will operate in a smaller V.

This flat wire is peculiarly fitted for use with automatic welding machines since it will give broad, smooth runs without the complicated side to side motion.

*Electrical Engineer, Quasi-Arc Electrode Company.

Steel Vaporized in the Arc

And Exposed to the Air becomes oxidized and chilled.

Consequently the weld is often brittle and porous.

It may hold under strain—and it may not.

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ELECTRIC RESISTANCE WELDING

By Chas. H. Kicklighter

IN an article entitled "Spot Welding and Some of Its Applications to Ship Construction" Mr. H. A. Winne of the General Electric Company has very forcefully and convincingly shown the advantages of spot welding over riveting in giving (a) an increase in strength of joint, (b) a saving of time, (c) a saving of labor and (d) a saving of material. The disadvantages he states are that the "welder is heavy and cumbersome and requires a considerable amount of single-phase power."

I propose to show that these disadvantages can be largely overcome by reducing to a minimum the mechanical pressure and the strength of current necessary to effect a weld and, therefore, a comparatively *light and portable welder* can be employed which can be swung from a crane and quickly adjusted to the work at hand.

Advantages

Mr. Winne has shown that a spot welded joint "can be so made that it will be stronger than the plate itself by simply making enough spots." He has explained how the great saving

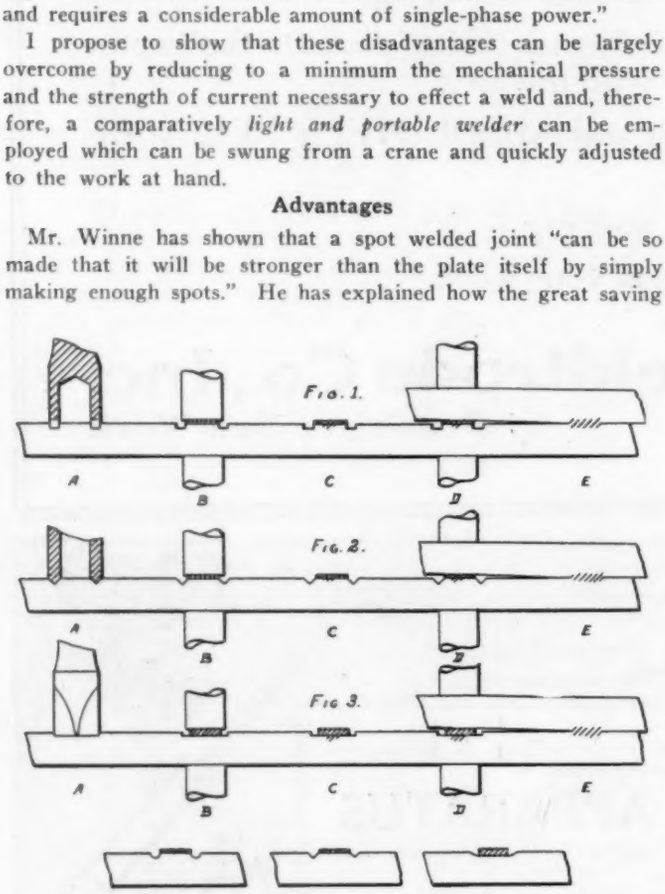

Fig. 1a. Fig. 1b. Fig. 3a.

in time, labor and costs are effected due to the elimination of the accurate laying-off-operation and of the punching, reaming and bolting together of the various parts. Again there is no handling and heating of rivets as required in riveting operations. More than one weld can be made at a time and "a smaller number of welds than of rivets is required for the same strength of joint." A marked saving of material is effected because no material in the form of rivets is used and the plate edges do not have to be lapped as much as for riveted joints.

Disadvantages

Mr. Winne continues, "the disadvantages of welding as compared to riveting, applied to plates of the thickness used in shipbuilding are the welder is heavy and cumbersome and requires a considerable amount of single-phase power. . . . . We must exert a heavy pressure (as much as 20,000 or 30,000 lbs. for plates ½ in. to ¾ in. thick) between the electrodes. In addition to this we must cause a current of 25,000 to 50,000 amperes to flow—must have a throat deep enough to span a plate 5 ft. in width, which means that it must be strongly and consequently heavily built in order to obtain the requisite pressure between the electrodes."

Disadvantages Can Be Overcome

I have repeatedly made substantial welds between stock ⅜ ins. thick on a light 20 K. W. welder with a comparatively light mechanical pressure and small flow of electric current. My method is simple and practical.

I am aware of the fact that when it is attempted to weld thick plates by the usual spot welding method, a tremendous pressure is required to overcome the irregularities and rigidity of the cold plates and to force them into firm contact between the welding terminals, and even then a large current is required as this current spreads out considerably upon entering the plates and much of the heat is wasted.

But I have devised methods by which the area subjected to pressure and to the passage of the heating current is quite limited,—in fact it is narrowed down to the area of the desired weld itself. Consequently the mechanical pressure required and the amount of heating current necessary are relatively small. A light and portable welder can in this way be utilized to make welds between large and thick plates. Such welding machines can be quickly swung into place and adjusted, as desired, by the limited crane facilities at the various ship ways. In a similar way, an even lighter welder, with a throat of much less depth, can be sent to the sites of erection and employed in the construction work of bridges and steel frame buildings,—for it is evident the electric welder can also be employed to weld angle irons, channel irons, fish plates and braces to other structural members.

My Method

My method is to weld both plates to intermediate bodies and while these bodies are soft and plastic to force them into surrounding depressions in one of the plates so that the plates may come into immediate contact. The intermediate bodies are in the shape of flat discs, as plain surfaces of contact give best results and require less welding current. This is true because all points of such surfaces are brought to a welding heat at about the same instant and a thorough fusion at all points is obtained by the time the metal is softened sufficiently to be forced back and crowded into the depression. The depressions around the discs are essential, as it is difficult to force the plates into immediate contact without these depressions. The above operation is simple, practical and easily accomplished. The writer has made numbers of such welds. The operator can rest assured that a thorough weld has been effected when the disc is softened sufficiently to allow the plates to come into immediate contact. The discs are previously fastened to one of the plates with depressions formed in the plate surface around these depressions. The discs are usually fastened by fusion, which must be sufficient to hold them in place during subsequent handling. The current required for this fusion is quite small. If the fusion is not complete, it is well,—as a thorough weld is effected during the final welding operation. The preliminary operation of fastening on the discs and forming the depressions is a shop operation to be effected at the factory on one plate only. The final operation of bringing a plane plate in contact therewith and welding thereto may be a field operation to be accomplished at the site of erection or at the ship ways by a portable welder. I have employed several methods for performing the preliminary operation as follows:

First: (Fig. 1). I have cut annular depressions in the surface of a thick plate with an annual cutter and have fused discs to the plate surface within the annular depressions.

Second—(Fig. 2). I have formed annular depressions in the surface of a thick plate by forcing a die upon heated spots thereon and have fused discs to the plate surface within the annular depressions.

Third—(Fig. 3). I have cut circular depressions, preferably with flat bottoms in the surface of a thick plate by a flat end drill or reamer and have fused discs to the bottoms of these depressions. These discs are of a less diameter than the diameter of the depressions but of a greater thickness than their depths so that the flat surfaces of the discs project beyond the surface of the plate.

In each of the above (i. e. Figures 1, 2 and 3) A and B illustrate, respectively, the forming of the depressions and the fusing on of the discs in the several methods. Any one of these may be used at the shop in the preliminary operation. C illustrates the prepared spots on one of the plates ready for the final welding operation. D illustrates the final welding operation on the ship ways, at the site of erection or elsewhere, in which case a plane plate is brought in contact with the projecting disc surfaces and the contacting parts are subjected to pressure and heating electric current. E illustrates the completed weld, in which case the disc has been welded to both plates and forced into the depression so that the plates come into immediate contact.

It will thus be seen the entire welding operation consists of but two parts (1) the preliminary operation A and B and (2) the final welding operation D. (1) the preliminary operation A and B is simple and may be easily and rapidly performed. It is of no more trouble than the preparation of plate edges for the arc welding process.

Simple Apparatus Used

When the depressions are formed by cutting or drilling, as in Figures 1 and 3, depressions may be cut and discs fused on simultaneously by the same machine, thus necessitating but one handling of the plate in the preliminary operation. Figures 4, 5 and 6 illustrate such a machine. Figure 7 illustrates the cutter for a machine in the method of Fig. 1 and Fig. 8 the cutter for the method of Fig. 3. In the machine of Figs. 4, 5 and 6, two drills or end cutters, 1-1, in this case individually driven by small motors 2-2, together with two welding electrodes 3-3 are mounted side by side on the frame 4 of the machine. Cutters 1-1 are operated through equalizer bar 5 by handle 6 pivoted at 7. Adjustable stops may be attached to regulate the depth of the cuts. The welding electrodes 3-3 are operated through equalizer bar 9 by handle 10 also pivoted at 7. These electrodes 3-3 are the terminals of secondary 11 of a transformer having primary windings 12 and core 13. Fig. 6 shows how the cutters 2-2 and the electrodes 3-3 occupy a staggered relation so as to prepare the plate for the rows of spot welds in staggered relation. The machine may be adjusted for any pitch desired, if the plates 14 and 15, supporting the cutting and fusing apparatus, be made adjustable relative to each other and if the positions of cutters and electrodes thereon be adjustable. The supporting frame 4 may be made quite light and the mechanical pressures required for feeding the drills and for fusing the discs are small.

In the machine, illustrated by Figs. 9, 10 and 11 one cutter 1 and electrodes 3-3 for fusing one disc are mounted on the same frame 4 of the machine. The cutting tool 1 with its motor 2 is mounted on a supporting plate 14 adjustable by means of clamping bolts 16 so as to provide means for changing the pitch distance. Container 17 is provided for holding the discs which may be fed automatically by trigger mechanism 18 to the desired position between electrodes 3-3.

Figs. 12, 13 and 14 represent a machine adapted to perform the preliminary operations according to the methods of Fig. 2, that is, stamping annular depressions on heated spots of the

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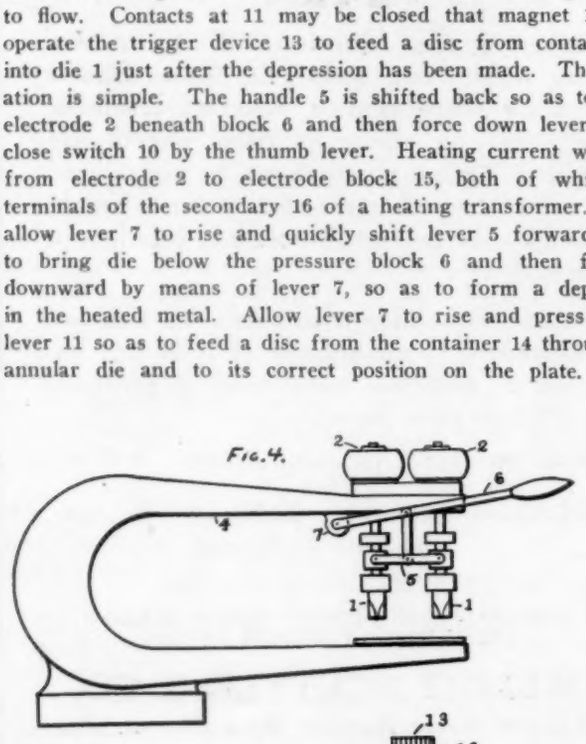
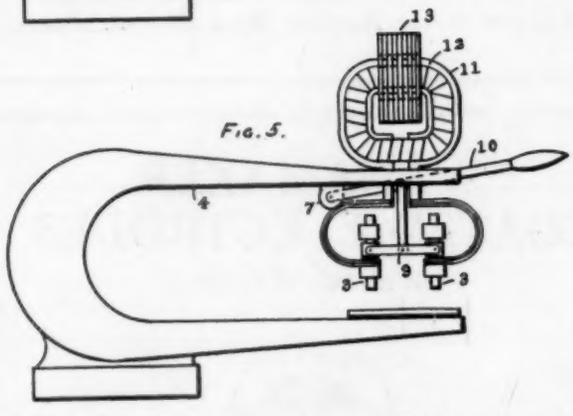
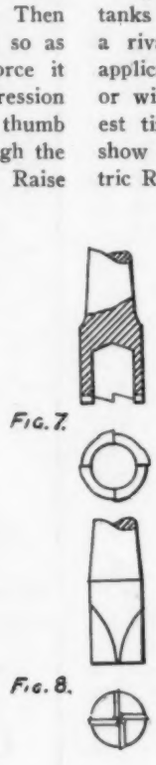
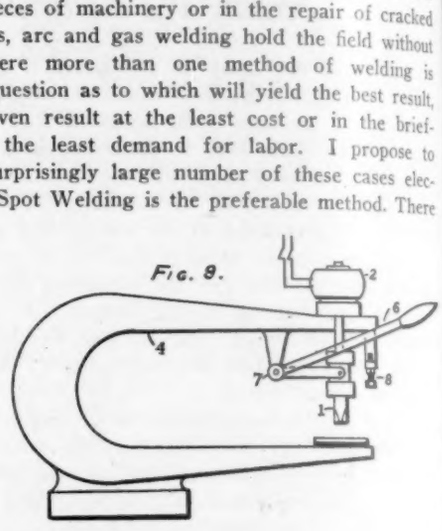
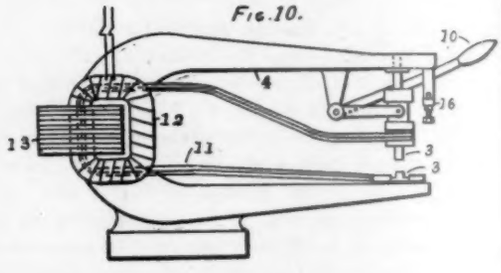
plate surface and fusing the discs therein. A die 1 and an electrode 2 are mounted on a shifting lever 3 pivoted at 4 and provided with handle 5. A pressure block 6 may be forced down by lever 7 through toggle-joint mechanism 8. Block 6 is guided downward by means of a lever fulcrumed at 9. Contacts at 10 may be closed so as to cause the welding current to flow. Contacts at 11 may be closed that magnet 12 may operate the trigger device 13 to feed a disc from container 14 into die 1 just after the depression has been made. The operation is simple. The handle 5 is shifted back so as to bring electrode 2 beneath block 6 and then force down lever 7 and close switch 10 by the thumb lever. Heating current will flow from electrode 2 to electrode block 15, both of which are terminals of the secondary 16 of a heating transformer. Then allow lever 7 to rise and quickly shift lever 5 forward so as to bring die below the pressure block 6 and then force it downward by means of lever 7, so as to form a depression in the heated metal. Allow lever 7 to rise and press thumb lever 11 so as to feed a disc from the container 14 through the annular die and to its correct position on the plate. Raise











handle 5 and shift backward so as to bring electrode 2 over the disc and beneath pressure block 6. Pull down the handle 7 lightly and press lever 10. Current will flow which will fuse the disc in place.

The methods for bringing the plates between the welding electrodes or for adjusting the electrodes of a portable welder to the plate edges for the final welding operation will not be discussed. Such methods are well known and will readily suggest themselves under the varying conditions met with. However, Fig. 14 is presented to illustrate how simple it is to handle cylindrical work and to bring the seams thereof between the welding electrodes 1-1. Castor rollers 2-2 permit the cylinder to be adjusted for tranverse seams. The rollers may be moved closer or further apart and supported in appropriate holes in table 3 so as to accommodate cylinders of various diameters. The wheels 4-4 rest on tracks 5-5 so that the carriage 6 may be moved forward or backward to allow for longitudinal adjustment. By means of hand wheel 7 and gears 8 four sprocket wheels 9-9-9-9, connected by a sprocket chain and mounted on screws 10-10-10-10 at the corners of table 3, are operated so as to raise and lower the table 3 and thus adjust the plate edges up or down relative to the electrodes 1-1.

Enormous Field For Resistance Welding

That welding will eventually and probably very rapidly supersede riveting in most cases where the latter is now employed is very generally conceded by those acquainted with the rapid developments and great strides recently attending the use of the former. Most of this, under the direction and encouragement of the American Welding Society, has been in the field of arc and gas welding for heavy work. I contend that Resistance or Spot Welding is preferable to arc or gas welding in many fields where the latter are being advocated. True arc and gas welding have a field where spot welding is not applicable or is applied with difficulty. For work in inaccessible corners or upon broken pieces of machinery or in the repair of cracked tanks or containers, arc and gas welding hold the field without a rival. But where more than one method of welding is applicable it is a question as to which will yield the best result, or will yield a given result at the least cost or in the briefest time or with the least demand for labor. I propose to show that, in a surprisingly large number of these cases electric Resistance or Spot Welding is the preferable method. There is a broad field in the welding together of heavy metal plates or of structural forms, such as beams, columns, braces, etc. where resistance welding has many advantages of other forms of welding, I believe. Truly enormous is the field for its application in the building of ships or in the fabrication of structural parts where steel plates and forms are used.

Resistance Welding (i. e., Disc Depression Method) vs. Arc Welding

As gas welding has been more satisfactory for thin materials, ⅛ in. and under, and for general repair work, a comparison between my method of resistance welding and the method of arc welding alone is considered essential. I submit that my method of resistance welding on thick plates and heavy work has the following advantages over the method of arc welding where both are applicable:

(A) Greater Speed.
(B) Successful in Hands of Unskilled Operators.
(C) Better Quality of Work.
(D) More Free from Internal Stresses.
(E) Greater Strength and Reliability.
(F) Not So Many Variables.
(G) Not Dangerous or Annoying to Operator.

(H) Saving in Power.
(I) Comparison in Preparation of Parts.
(J) Comparison in Automatic Operation.

The writer takes the liberty of quoting statements from a number of authorities in support of the above contentions.

(A) Greater Speed

"Arc Welding is relatively slow.—Spot Welding is much more rapid and saves more labor."—C. A. Adams. Speaking of the Spot Welding Process Hermann Lemp states that it "easily surpasses the gas and electric arc process as regards both speed and excellence of finished product." "In a research made by Mr. William Spraragen for the Welding Research Subcommittee on several tons of half inch thick ship plate the average rate of welding was only two feet per hour.—For a 12 ft. cube tank of one-half inch thick steel welded at Pittsfield the speed of welding was three feet per hour."—H. M. Hobart. These were the actual periods of welding after the plates had been clamped and the preliminary work of preparing the edges had been done. "One of the largest ship building concerns in the United States reports that the general average of all its manual welders on this class of work is from one foot to eighteen inches per hour."—H. D. Morton (Speaking of welding one-half inch ship plates). The writer made a number of spot welds on 3/8 in. stock with a 20 K. W. welder at an average speed of 20 seconds per weld. With a greater capacity welder a greater speed of welding could have been easily attained.

(B) Successful in Hands of Unskilled Operators

No great degree of intelligence or skill is required to operate a spot welding machine. With a reasonable amount of care any workman of ordinary intelligence can successfully operate one. The operator can be practically sure that when the disc has become sufficiently plastic to be forced into the depression a thoroughly welded union has been effected with both plates. "Spot Welding requires less skill on the part of the operator and lends itself more readily to effective inspection.—It is now certain that where the strength and ductility of a weld are important thoroughly skilled operators are necessary and that such cannot ordinarily be produced with less than six to eight weeks training."—C. A. Adams. Commander S. V. Goodall speaking of arc welding advises ship builders to employ only thoroughly skilled and experienced workmen stating that thoroughly rotten work is done by unskilled welders and that it is impossible to tell when the work is good or bad without a destructive test. "That about ninety-five per cent of the welding results is dependent on the skill of the operator and that at least six months practice is necessary to acquire reasonable satisfactory efficiency."—H. B. Morton. (Speaking of Arc Welding). "It is very difficult to find welders capable of doing a variety of work with success."— T. T. Heaton. (Speaking of Arc Welding).

(C) Better Quality Work

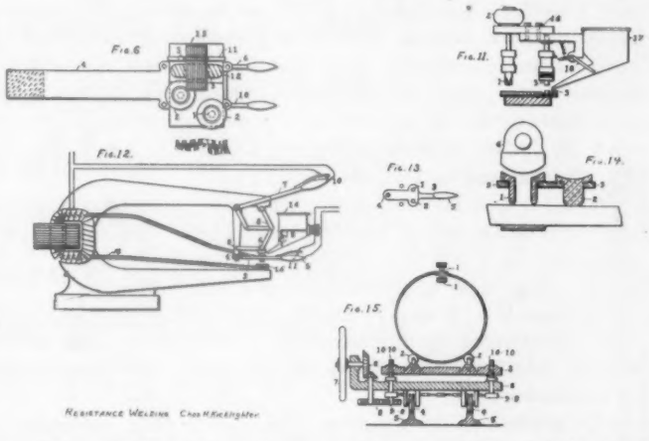
There is less opportunity for oxygen and nitrogen to gain access to the weld so as to contaminate it, effect the ductility of the weld. Moreover, in my method it is found that the extruding of the plastic disc metal from between the welded surfaces into the depression frees the spot welded area from blow holes and results in a stronger and more compact metallic bond between the plates. Speaking of Spot Welding Hermann Lemp states that "parts to be welded are substantially protected against contact with oxygen of the air and what few oxides may be formed near the edges are effectively squeezed out." "It is notable that most of the carbon and manganese is burned out in traversing the welds."—H. M. Hobart (Speaking of Arc Welding).

(D) Free From Internal Stresses

Note that in my method the most of the heat is confined to the discs and the parts of the plates in immediate contact herewith. Because of the limited volume of metal heated, locked up cooling stresses are to a great extent avoided. "Greater cooling stresses are developed because larger areas of adjacent metal are heated."—H. M. Hobart. (In comparing arc welding with gas welding.) "In plates this size, if electric arc welding is attempted the heating introduces dangerous internal contraction stresses and it is obvious that in the construction of a ship's hull an annealing process to eliminate these stresses is out of the question."—L. C. Lincoln.

(E) Greater Strength and Reliability

"Spot welded joints can readily be made stronger than the plates joined."—C. A. Adams. "Obviously a welded joint can be so made that it will be stronger than the plate itself."—H. A. Winne. In arc welds the deposited metal is almost pure iron and is weaker than the plate metal, but in spot welds "the spots more nearly approach the original composition of plate as the slag driven off (a measure of a chemical change within metal) is inconsiderable compared with that of arc welds," according to John Martin. F. M. Farmer tells us that in arc welds the fatigue strength of deposited metal is less than that of original metal, as in fatigue tests failure always occurs in deposited metal. "Owing to the relative brittleness of arc welded joints much fear has been expressed as to their ability to stand long continued vibration stress and shocks."—C. A. Adams. "At present, it is not possible to insure that two consecutive welds made under apparently identical conditions will give even approximate similar results under tests."—C. R. Darling. (Speaking of arc welding).



(F) Not So Many Variables

In Resistance Welding, the mechanical pressure, the strength of current and the time are the variables. All of these are relatively small in value in my method of resistance welding. The mechanical pressure should not be so great as to force the disc into the depression until the heat has thoroughly fused the disc to both plates. As the strength of current is increased the time of welding is decreased. But there are many variables in arc welding, some of which are as follows:—Length of arc, size of electrodes, composition of electrodes, strength of current, voltage, preliminary preparation of plates, thickness of plates, time, degree of bevel of plate edges, expertness of operator, etc. "If a year ago it had been realized that there were thirty-three variables in the arc welding and but three in the spot welding problem, the latter would have determined perhaps the more fruitful field for experimental investigation in seeking a satisfactory weld for ship construction. The writer heartily endorses the author's (i. e. H. M. Hobart's) belief that spot welding has a great future as applied to ship building."—John Martin. April, 1919.

(G) Not Dangerous or Annoying to Operator

In arc welding, operators are liable to receive shocks on account of the higher voltages handled. Injury to the eyes and burns are often received. It is necessary for operators to

wear goggles for the protection of the eyes, and masks and gloves for the protection of face and hands. These are a source of annoyance, discomfort and inconvenience. It is a well known fact that welders often become very nervous in their efforts to maintain a constant length of arc, prevent flashing-out, continue the movements necessary to do a good job, etc. In resistance welding there are no high voltages to handle, no glare to annoy, no goggles and mask to inconvenience and no constant strain to maintain conditions so as to secure good results.

(H) Saving in Power

I am confident that with my method of resistance welding there is a much smaller consumption of power. There are two reasons for this, viz. the small amount of time consumed per weld and the limited volume of metal in which heat is developed. This latter consists of the disc and surfaces of the plates in contact therewith. I judge that the consumption of power by my method is about one tenth of the consumption by the ordinary spot welding method. Mr. J. M. Weed, of the General Electric Company, states "that for welding plates ⅛ ins. to ¼ ins. in thickness, the single phase currents required would be from 30,000 to 50,000 amperes and the kilovolt-amperes required at 60 cycles would range between 300 and 900 at power factors of from .35 to .50 ins. "If Mr. Weed requires 300 kilovolt amperes to spot weld ⅛ in. plates by the ordinary method and I welded ⅛ in. plates together at the same speed on a 20 K. W. machine, using as much as 30 kilovolt-amperes, my method would require one-tenth the power of the usual spot welding method and, I dare say, the power consumption was much less than that consumed in welding the same number of feet of seam by the arc welding method.

(I) Comparison in Preparation of Parts

Objection may be made that preliminary preparation is necessary in welding by my method. I will state that this preparation is

(a) made upon only one of the plates to be joined.

(b) simple and may be rapidly performed.

(c) performed by one handling of the plate through a machine in which the depressions are cut and the discs are welded on simultaneously.

(d) performed in the shop where there are facilities for easily and rapidly handling of the material.

(e) performed upon comparatively light and inexpensive machines.

(f) performed by workmen having no special experience, aptness, or training.

(g) performed without accurate laying-off, the spacing being done by eye or by automatic means.

Mr. Hobart states that spot welding does not require as much preliminary cleaning of surfaces as does fusion welding. The cleaner the surface the better the weld in fusion welding. In discussing arc welding he also states "this preliminary work and the preparation of the edges, which is quite an undertaking and requires other kinds of artisans, accounts for a large amount of time and should not be underestimated." Considering the fact that for a first class job of arc welding both plates should receive a preliminary preparation of their edges by cleaning, beveling, etc., it is not considered the preliminary preparation which I give in my method is any grounds for serious objections, especially when it is taken into consideration that the final welding operation which may be field work at the site of erection is effected with such a great saving in time, labor, material and cost.

(J) Comparison in Automatic Operation

Objection may be made that the arc welding method possesses greater adaptability to automatic welding. I do not believe that this is true. I am aware that there are machines for the automatic feeding and moving of the arc in arc welding. These machines are primarily for shop operations and their fitness for quick adjustment to field work does not offer any advantages over spot welding method. A vast amount of investigation has been made and much time and money expended in developing apparatus for arc welding. Very little has been done along this line in the field of spot welding of heavy plates. It is a simple matter to design suitable automatic machines,—that is means for handling and welding the plates according to my method along the lines hereinbefore suggested. Very simple automatic machines for performing the preliminary operation of cutting depressions, welding on discs and feeding the discs to the work as needed suggest themselves.

Hermann Lemp Method

A method, somewhat related to my method, has been suggested by Hermann Lemp, of the General Electric Company, in the May, 1919, issue of Bulletin of American Institute of Mining and Metallurgical Engineers. His preliminary method of punching rounded teats by a punching press at first appears to be a much simpler method than my method of cutting depressions and fusing on discs. But a much heavier machine is necessary for this operation on account of the greater pressure required and about as much time is necessary to handle the plates through the machine as is necessary in my method. Moreover there are *three serious objections* when it comes to his final welding operations, viz.: the rounded form of the teats, the form of electrodes and the necessity for two operations in order to bring the plates into immediate contact. I find it much better to have the areas of initial contact flat and practically equal to the areas of the desired weld. This results in a stronger and more reliable weld and requires less welding current. Therefore, a welding machine of less capacity and which is lighter and possessive of greater portability can be used. I find that, with plane surfaces of initial contact, all points of such surfaces are brought to a welding heat at about the same instant and a thorough fusion of the metal at all points is effected by the time the discs are softened sufficiently to be forced back and crowded into the depressions. My experience with rounded projections, similar to the teats used by Mr. Lemp, is that the apex becomes first fused to the contacting plate and then serves to conduct or short circuit the welding current until the teat softens and flattens out while the surrounding surfaces of the teat and plate which are thus brought into contact are relatively cold and their fusion does not occur. To off-set this Mr. Lemp has employed a large, annular, hollow, and complex electrode with a steel plunger working therein. This steel plunger requires hydraulic or pneumatic means for separate operation. More time for the complete operation is necessary and a heavier and more complex welder is required. A greater consumption of power than by my method is required, as a less volume of metal is heated. I submit my method possesses the following advantages over the Lemp method:

(a) Greater simplicity of welder construction.

(b) Greater lightness and portability of welder.

(c) Less power consumption to effect the weld.

(d) Less time to effect the weld and complete the operation.

(e) One operation instead of two.

(f) Smaller, simpler and more durable electrodes.

(g) Plane plate surfaces for the electrodes to contact with.

The following parties who have been in close touch with the development of electric welding are quoted in the foregoing article.

C. A. Adams, Dean Harvard Engineering School, Harvard University.

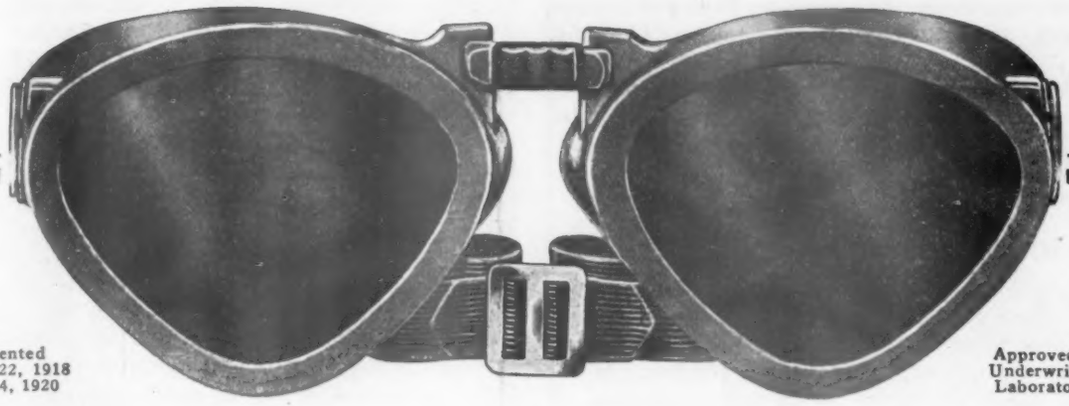
H. M. Hobart, Consulting Engineer, General Electric Company.

Hermann Lemp, Engineer Erie Works, General Electric Company.

H. A. Winnee, Power and Mining Engineer, Depart. General Electric Company.

J. M. Weed, Power and Mining Engineer, Dept., General Electric Company.

Commander S. V. Goodall, Naval Constructor, R. N.



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G. C. Lincoln, Pres., Lincoln Electric Company, Cleveland, Ohio.

John Martin, American Bureau of Shipping, New York.

F. M. Farmer, Chief Engr., Electric Testing Laboratories, New York.

T. T. Heaton.

Chas. R. Darling.

QUESTIONS OF A WELDER

AT a recent convention of welders and apparatus salesmen in Texas, Mr. Ben K. Smith, of the Big Three Welding & Equipment Co., Fort Worth, Texas, addressed the meeting on the subject of Autogenous Welding. At the conclusion of the address Mr. Smith was called upon to demonstrate welding problems and a great many questions were addressed to him, among them being the following:

Q. Can Nickel steel or rear axle shafts be welded successfully?

A. Yes. Bevel the shaft from both sides. Place each end in a V block, as level as possible. Melt the edges from top to bottom, so as to join the sharp edges from its own metal. Then bend one end of the welding rod about six inches long to a 45 degree angle or less and commence to weld about half the bevel. Turn shaft and weld the other bevel about a half. Turn the shaft again to complete the weld and proceed in the same way on the opposite side. After welding anneal the weld and neighboring metal for about four inches.

Q. What kind and size of rod should be used, and why the bending of the rod?

A. Use a 5/16" nickel rod. Bending the rod affords a better chance to work and penetrate to the depth of the weld.

Q. Would like to have this rear axle shaft welded and tested by hammer blows.

A. Shaft was welded and after four hard blows with a 12 pound sledge it broke about 1¼ inches from the weld.

Q. Can spring steel be welded successfully.

A. No. The best way to make an emergency or unguaranteed weld is to place the broken leaf into a good one; melt the broken edges in circles until the bottom is reached, so that the weld will be completed with two-thirds of the spring metal. Then add the other third with Norway iron rod (5/16"). Turn the leaf over and repeat the operation.

Q. Which is the best method of welding aluminum cases, with flux or with the puddling method?

A. The puddling method is the best.

Q. How do you determine when an aluminum case is preheated sufficiently?

A. When it is hot enough to melt a bar of half and half.

Q. How can an aluminum weld be finished neatly with the torch?

A. Heat the surface of the weld slightly and sprinkle a little 20 Mule Team Borax on the surface of the weld. Then reheat the weld and a smooth, polished finish will result.

Q. Which is the best method of preheating crank cases?

A. Oil, gas or charcoal are all good preheating agents.

Q. (By a welder in attendance.) I have a better method. I place the crank case in boiling water, leaving the cracks to be welded exposed. After the case is welded I gradually drop the case into the water, or increase the amount of water, so as to cover the whole case, and cause same to boil for five minutes after welding, and then allow the case to cool gradually.

A. This method would seem to be open to considerable criticism. Not having tried the system I am unable to discuss same.

Q. (By a Boiler Inspector.) When is the weakest point of iron or steel to be known by a welder?

A. When the color changes from dark red to black.

Q. I welded a bronze bell successfully, but I cannot replace the silvery tone. How can it be done?

A. Use a Phosphor **Cast** Bronze rod. Drawn Tobin bronze, or any other drawn wire or rod is not good for welding a bell. If the right rod is used allow the bell to cool and then reheat to the point where the bell will melt solder, and then temper bell in cold water. This will restore the original tone.

Q. Is there any method of dressing up a scored cylinder when it is repaired with a silver-nickel alloy?

A. Yes. Before the metal sets push the piston and one ring into the bore. This operation is bound to remove all excessive metal from the bore without further dressing.

Q. Can galvanized iron be welded successfully?

A. This depends upon the article to be welded, the shape and dimensions. It would be better to braze galvanized iron, because the zinc will not be burned off, leaving a surface exposed to rust.

Q. What is the best brazing rod or wire for galvanized iron?

A. The regular 1/8" spelter or brazing wire.

Q. I have a great many cylinder heads that are cracked on top at the water jacket. The crack starts about two or three inches from the end and extends more or less in the water jacket. I weld them with the preheating method and find that in nine cases out of ten the heads are warped and crack across the weld. How shall I weld without cracking or warping?

A. If possible bolt two cylinder heads together with four bolts. With a hack saw, saw off the uncracked portion at the flanged end, so as to make a continuous break. Start the weld on the extreme end of crack, proceeding as fast as possible until the flanged end is reached. Turn the other head over and repeat the operation. Preheating is not necessary with this method.

Q. I have a piece of white metal with a lug broken off. I could not weld this metal as it blew away into a sort of oxidation worse than aluminum.

A. White metal, which is known under several names, cannot be welded successfully, because it absorbes a great deal of oxygen. In some cases this metal has been repaired by the following process; surround the broken piece with a mould made of welding compound. Use half and half bar solder, mixed with Antimony, about 1/8th pound to a bar of solder. Use boiled muriatic acid as a flux. Melt the bar of solder into a small ladle and have same prepared in a molten condition. Then heat the fractured edge or crack and then with the use of a steel paddle (as used for aluminum), carry some of the molten solder into the mould and slowly paddle same into the white metal. Do not heat too much, because the white metal does not fuse very readily. If heated too much this metal will disintegrate. When it appears difficult to join the two metals apply a little of the muriatic acid with a brush. The metal must be worked the same as cast aluminum.

Q. I had a heavy hydraulic cylinder to weld. The crack was about 18" long and the metal was about 4¾" thick. Although I preheated and used my largest tip I could not fuse the metal. Apparently I could not get sufficient heat to keep the metal fused.

A. One torch was not sufficient. For such heavy work two torches are necessary. You could place a Tee on your generator and draw your acetylene for both torches from the same generator. In such cases you should also have an extra oxygen regulator and an extra set of hose.

Q. I had a large tractor cylinder cracked like a cross on the face of the water jacket. I have welded hundreds of them with success, but I could not weld this one. The weld

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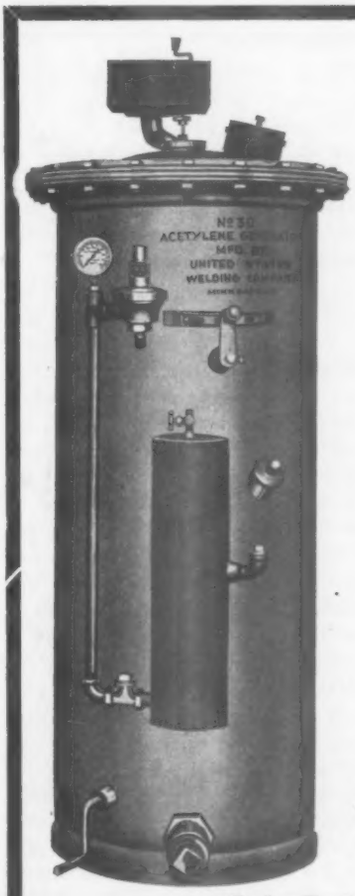

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would always crack in cooling. I preheated the cylinder slowly to a cherry red and after welding it, and while at a red heat I placed the weld in the ashes and fire. I then covered the furnace and allowed 24 hours for cooling. When I opened the furnace the welds were cracked in the same place. I repeated this operation four times and finally gave it up.

A. Welding failures are sometimes hard to explain. Try cutting out the cross cracks into a circle. Then take a round cast iron patch from a scrap cylinder. Preheat cylinder same as before and weld in the patch.

Q. We have a great many cast iron kettles or tubs to weld. They generally crack one-half or two-thirds across. How should they be welded?

A. Break the kettle in two halves before welding. Start to weld from one end and do not stop until the weld is completed. Preheating is not necessary.

Q. What process is best for lead-burning, oxy-acetylene or oxy-natural gas.

A. The beginner should use oxy-natural gas, because it is slower and gives him a chance to learn. For the experienced man oxy-acetylene is best, because it is much faster. Time saved in using oxy-acetylene will more than equal the difference in the price of gases.

Q. I have a large galvanized welded tank, with a 12" crack on the seam. When I weld this it opens up again on the seam, and the crack usually grows longer.

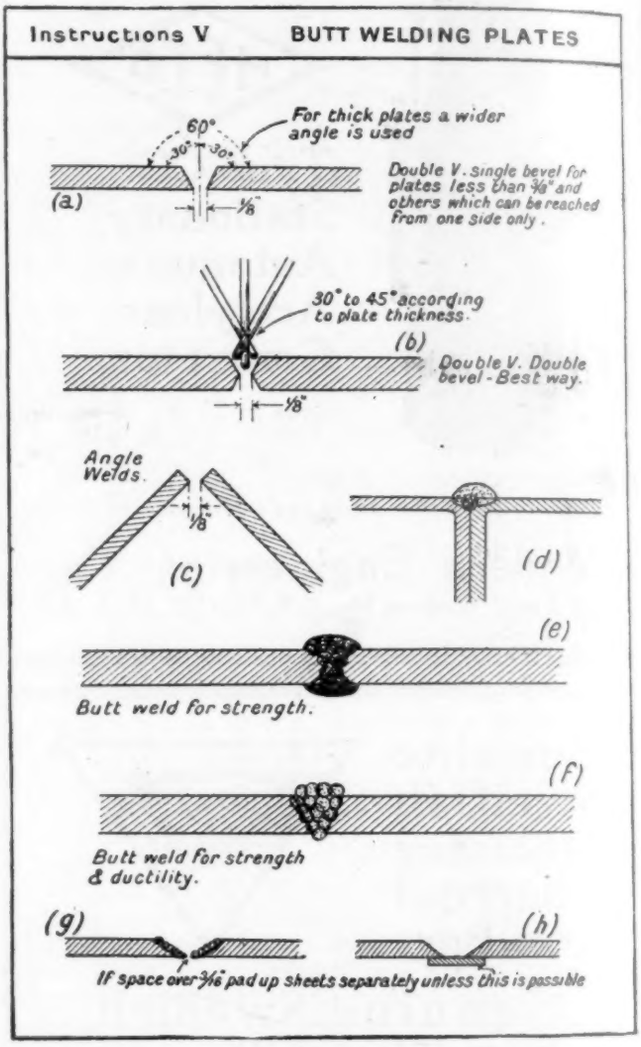
A. Drill two ¼" holes on each end of crack. Heat the cracked edges and flange towards the inside. Remove all scale from the edges and, if possible, get the edges bright. Use a small tip and braze the opening, starting from one end to the middle of crack. Then start from the other end and finish at middle. If welding is preferred weld the same way. The curves created by flanging will take the strain from the original seam.

BUTT WELDING*

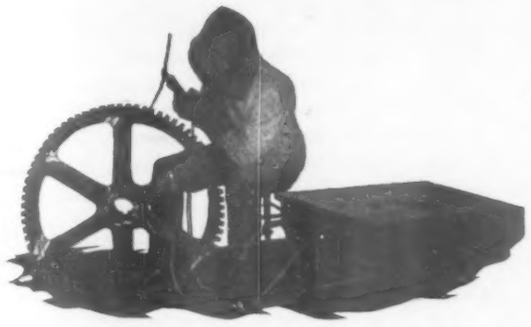
BUTT Welding, especially of plates, is the most satisfactory method, and in general is much stronger than lap welding unless with the possible exception of a joggled lap weld, i.e., one or both of the plates bent in lapping so that the weld is in the direct line of the pull or stress, which in the case of a joggled weld with one plate only joggled may be virtually a butt weld, with the additional overlap welded edge of the plate in which the jog is made.

Lap welds in general are not as strong as butt welds, because of the tearing and twisting strains due to the weld not being in the line of stress. A weld with additional plates such as the strap weld is stronger than a plain butt weld, but in fact, a butt weld is used as a foundation for strap welds. Riveting and welding where strength is the quality desired do not mix with advantageous results. For instance, one might expect that 50 per cent strength could be made in a joint by riveting and the other half by welding, or that 50 per cent of the strength could be made by spot welding and the remainder by arc welding. This assumption has been proved entirely erroneous, and an explanation is that in plates the joints are called upon to withstand the stresses one at a time, and that cases arise where the strains come on in a wave, so that the maximum at one point may be more than the factor of safety for half the strength of the plate, and would tear off different kinds of welds at 50 per cent strength, like buttons on a coat, if the pull were on one at a time, whereas a direct pull coming against all the buttons would be withstood, and could be relied upon for the figured strength. In other words, the riveted joint must be considered at its strength and the spot or arc welded joint at its strength, and the strength of the joint be considered as the strength of the maximum, but not the strength of their addition.

In making a butt weld better results can be had by double-bevel double "V" as shown in Figure B, Instructions 5, but where the plate is not unduly large, i.e., less than one-half inch, but where access for welding can be had only from one side, the single bevel and double "V" is almost as desirable. For work thicker than ½ in. the single "V" has to be widened out to such an angle that the electrode can be added with assurance at the bottom of the "V" so that the amount of metal to be added is from two to three times as much as with the double "V." Geometrically, a single "V" is twice the area of a double "V," but in welding this ratio is not exactly borne out because in both the single and double "V" the butt edges are left slightly apart and this reacts more to the advantage of the single "V" than the double "V"; however, as explained above, due to depth of the opening the single "V" requires more metal to be added, takes longer, less chance to make a perfect weld and internal strains, if any, not balanced. In other words, if a single "V" weld of any appreciable thickness is made lying flat the ends of the plate will turn up like the wings of a bird. If the plate is held down there will be a strain in the weld of the adjacent steel, and if this strain is less than the ult strength, the steel will take it up; if not, a crack will result either in the weld



Instruction No. 5 from the handbook of the Electric Arc Cutting & Welding Co., 222 Halsey Street, Newark, N.J. Copies of the complete instruction book may be had from this company at $1.25 each.



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or the adjacent steel. The double "V" offers the solution of balancing these strains, especially if the weld is not made all at one time on one side, i.e., run the first bead on each side and then fill in on the side opposite to the second bead run. On large work two men sometimes work on a double "V," one at each side. The double "V" weld has the disadvantage of the great liability of the metal falling through the abutting edges, and as explained in article entitled "Temperature and Heat of the Arc" where no weld is made the metal is necessarily burnt because there has been no means for conducting the heat into the plate and lowering the massed temperature to the desired point for welding. If the correct heat adjustment of the machine was made for the metal to be burned from falling free there would never be a large enough crater in the parent metal to make a weld. Any metal thus falling through a double "V," if not cleaned out before the bead on the side is started, will exist as burned metal, or is liable to exist as slag due to the heat of the second bead completely devitalizing both the metal fallen through from the first bead and the new metal of the second bead, because the burnt metal of the first bead will not conduct away the heat which is required in welding into the parent metal. This is gone into detail to show that on imperfectly joined work, if the metal appears protruding it must be chipped off.

In a single "V" the protruding metal is of no moment as it is simply excess, and is not relied upon, nor does it get in the line of strain. It will be noted that, as in Figures C and D, there are many welds where the "V" is made without special machining, simply by ingenuity in the assembly of the parts to be welded. As shown in Figure B, the angle in any welding must be so open that the electrode can be held at approximately right angles to the face to be welded if there is to be any surety that the metal deposited from the electrode will be deposited in the crater, and in fact the arc cannot be guided so as to make the crater at successive points desired unless opening is as shown in Figure B, i. e., electrode at approximately right angles to the face to be welded. The angle of the weld then depends upon the thickness of the piece, and as pointed out, the virtual thickness can be cut in two by double veeing, double beveling. As shown in Figures E and F there is a respective choice of spreading methods in filling up either single or double "V" welds, and in general where strength only is desired, spreading can be used as in Figure E and is quicker, as highest current densities can be used as previously explained.

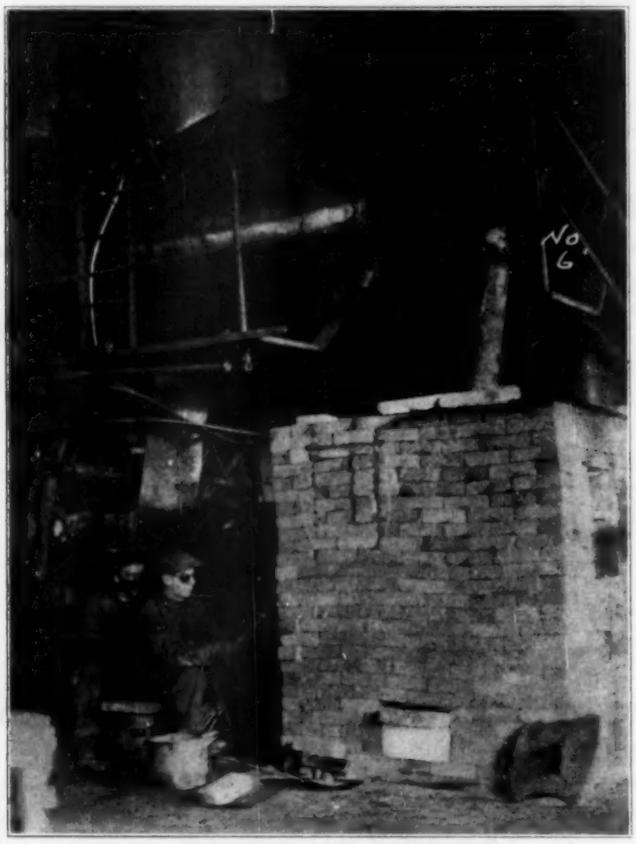
The first bead in the neck of the weld should not be made by spreading, as the operator will notice at his first attempt at butt welding that the centre of a double "V" double bevel weld will be entirely absent from any welding qualities, while the upper half and pad may be beautifully welded. It is also generally advisable to use the smaller size wire for their first careful work in the neck of the "V." In Figure F is shown the method of using successive reliably small beads, and this is by far the better method for careful results. Practical conditions, however, limit the number of these beads to four or five, say of ½ in. plate. A weld is a steel casting, and steel castings can never equal the ductility of rolled plates. Annealed steel castings show much more ductility and elongation than unannealed, and by putting down successively small beads, each bead annealing the previous one, and by adding a pad over all at a higher current density, the entire weld may be annealed, and the annealer bead may or may not be removed by machining.

In Figures G and H are shown two methods of overcoming too wide a gap between parts to be welded.

WELDING A LOCOMOTIVE CYLINDER

By H. J. Hughes

Here are some interesting photographs of a locomotive cylinder welded at Brunswick, Md., on the Baltimore & Ohio R. R., February 5, 1920. This is a Russian type U. S. Engine No. 1137. The entire end had been broken off the cylinder and there were also internal breaks. In order to complete



How the Preheating Furnace Was Built

the welding on the inside a piece had to be cut out. The same cylinder had been welded by the electric process, using studs and stitching over them over the line of the break, which made it more difficult than welding a clean break.

The studs and material that were used with the electric process were all cut out with the cutting blow pipe, and the crack was chipped out at an angle of 45 degrees, cleaning off

Entire End of Cylinder Broken

all the burnt slag and going all the way through the wall of the cylinder, running each side into a feather edge through the crack. Precaution was used while chipping was being done not to break large pieces from the inside, which would leave big holes and require more welding time.

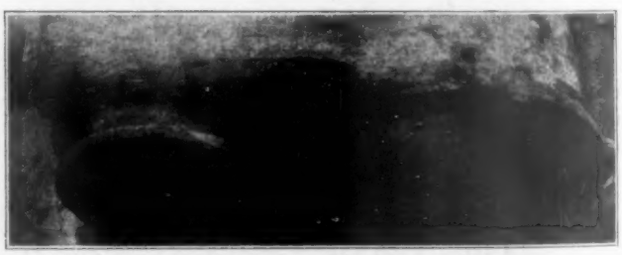
After all the chipping was finished, and a rack made of netting put through the center of the cylinder (this rack was constructed to hold the heat close to the center of the cylinder where most of the affected parts were) a furnace was then built, made of fire brick, with a sand bottom, in order to keep the fire from burning the floor, as the round house in which the cylinder was welded had a wooden brick floor. Draft holes were left around the bottom of the furnace just above the sand floor, to keep the fire burning while heating was taking place. While building the furnace, it was so constructed that brick could be removed two at a time, following the line of break and ports were left at each end and on the side at the bottom through which to apply fuel.

After the furnace had been completed, two lengths of cast iron rods doubled, were welded end to end. This was done

A Troublesome Internal Break

so that when welding was being performed you could keep away from the excessive heat. A sufficient amount of these rods were welded together to complete the job. Then the fuel was lighted at the bottom and allowed to heat gradually before lighting the fuel in the cylinder and valve chamber. At the end of about three or four hours the cylinder was in good condition to start welding, being at a cherry red heat. This heat was held at all times during welding.

While waiting for the cylinder to heat everything was prepared for the job, such as gas, oxygen and fuel, tongs to handle the hot brick to avoid having to stop and look up little things which would be needed after the welding had



The Finished Weld

been started. The weld was started at the cylinder head joint at the bottom on the outside and carried on in an upward manner until the extreme end of crack was reached over the top of valve chamber. The next weld was started next to the frame on the cylinder joint and welded in an upward manner. The next weld was started in the channel where the patch had been cut out and filled across same, then upward until the internal crack was welded. The last weld, which was the patch, was started at the cylinder head joint on the valve chamber at the bottom, welding to the left and upward, at which place it was completed.

Fuel was then replenished in the cylinder at all points. All ports and openings in the furnace were chinked and the heat was allowed to gradually die down and the furnace was left standing until the cylinder was absolutely cool.

The gradual cooling process was very necessary, as a sudden chilling of the cast iron would cause unnatural strains

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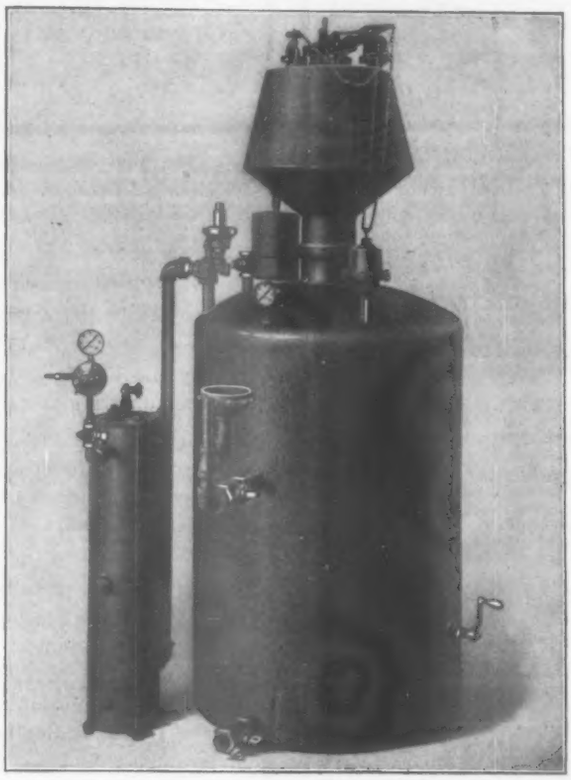

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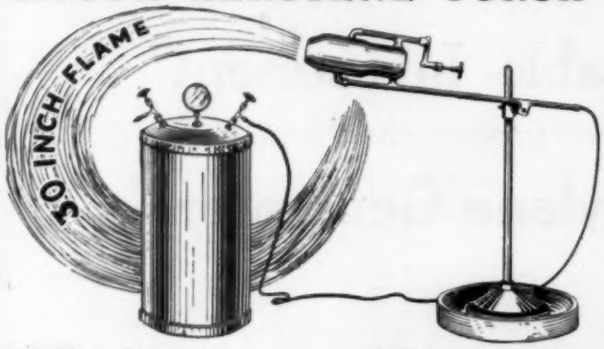

439 Mass Avenue Indianapolis, Indiana

NOTICE

Welders of Illinois Gas & Electric, if you want better wages and working conditions, wake up and join Chicago Local Lodge No. 301, Brotherhood of Gas & Electric Welders of America. Address C. H. Knight, Rec.-Secy., and Illinois State Organizer, 521 W. Jackson Blvd., Chicago, Ill.

CURRENT WELDING LITERATURE

WELDING HEAT-TREATED CHROME ALLOY STEEL, by J. Churchward.—Showing how it is possible to save a considerable portion of defective forgings by welding, provided only a building-up operation is undertaken. Microscopic examination shows how much the heat treatment has been affected. The main feature in welding heat treated material is to have controlled heat.—The Iron Age, Sept. 9.

WELDING CASTINGS OF DIFFERENT METALS—From a discussion of this subject by George B. Malone before the annual meeting of the American Foundrymen's Association at Philadelphia. The paper included brazing, preheating and welding large castings, salvaging by welding and welding of Monel-metal.—The Iron Age, Aug. 26.

WELDING SHOP LAYOUT EQUIPMENT AND WORKS COSTS, by Ethan Viall.—A description of one shop that does nothing but welding, with the method of keeping costs in this shop.—American Machinist, Sept. 2.

DEFORMATION OF PIECES IN COURSE OF WELDING, by M. Piette.—Especial reference to the deformations encountered in welding the various forms of sheet metal, and methods of offsetting them. A preliminary deformation in the opposite sense is recommended in most instances. In the case of containers welding along the side instead of on the edge is advised.—Revue de la Soudure Autogene, July-August.

AIR IN ACETYLENE APPARATUS.—The presence of air is injurious to the weld and productive of most of the accidents in acetylene welding. Suggestions for avoiding these mixtures and precautions against accidents.—Acetylene and Welding Journal.

BACKWARD AND VERTICAL WELDING, by W. B. Perdue.—Recommends that the beginner be required to learn Forward Welding first. Detailed instruction for the execution of backward welds. Vertical welds may be worked either from the bottom up or from the top down. The size of the tip has much to do with proper control of the metal.—Acetylene Journal, August.

ELECTRIC WELDING—HISTORICAL, by Ethan Viall.—A brief description of the various electric welding processes with diagrams of the machinery and devices employed.—American Machinist, Sept. 9.

THE MANUFACTURE OF OXYGEN, by C. Royer.—Description and illustration of types of electrolytic plants, details of operation, and points to be observed in comparing different styles.—Canadian Welding Journal, August.

NEW LIGHT WEIGHT RAIL PREHEATER.—In cases where it is possible to heat only one rail at a time it is more economical to use a light preheater. The article describes an outfit that will soon be placed on the market.—Reactions, Second Quarter, 1920.

CARBON-ELECTRODE ARC WELDING AND CUTTING, by O. H. Escholz.—Applications, electrodes and filler materials to use, arc manipulation, and arc lengths. Graphite electrode should be connected to negative terminal. Flanged seam welding, welding of non-ferrous metals, and cutting.—American Machinist, Sept. 9.

WELDING NEWS

The John A. Roebling's Sons Company, manufacturers of wire rope and wire, recently issued a 176 page price list, pocket size, listing and describing their entire line.

A chain of oxygen plants in Canada for separating oxygen from the atmosphere is contemplated by the Dominion Oxygen Co., Ltd., of Toronto, Canada. The first of these plants has just been completed at Toronto, and sites for additional plants have been secured at Montreal, Winnipeg, and other points.

C. J. Nyquist & Co., dealers in acetylene generators, oxy-acetylene apparatus and supplies, recently announced their new location at the Arcade Bldg., Cleveland, Ohio.

On September 1st the General Welding and Equipment Company moved from 107 Massachusetts avenue, to better and larger quarters at 74 Brookline avenue, Boston, Mass.

Catalog No. 20 of the Bastian-Blessing Company is just off the press. It illustrates and describes in detail the Rego line of welding and cutting apparatus, and contains a lot of snappy and readable selling talk on torch and regulator details.

The American Steel & Wire Co. has acquired from the Wickwire Spencer Steel Corporation the right to manufacture under their patents.

At the sixteenth annual convention of the International Railway General Foremen's Association, held in the Hotel Sherman, Chicago, September 7-10, the Torchweld Equipment Company had a complete exhibit of the Torchweld line of cutting and welding torches.

MORNING EXERCISE FOR TIRED WELDERS

Rise 6:00 A. M.

Stand in middle of room, raise arms slowly, take deep breath and say: "D--n the Government," lowering the arms in attitude of despair. Do this TEN times.

Extend body flat downward on floor, cover eyes with hands, kick heels, THINK OF THE RAILROADS AND WEEP—till DRY.

Kneel, wring hands, meditate upon labor unions and groan 150 times.

COLLAPSE on floor. Grovel vigorously, think of the INCOME TAX and GNASH YOUR TEETH as in anger. Follow until exhausted.

While cooling off, try to get A NUMBER on telephone.

NOTE:—Observe these simple rules very carefully, and you will reach the shop every morning with most of the cares and trouble of the day already out of your system.

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HOW TO TAKE THE GUESS OUT OF GAS WELDING

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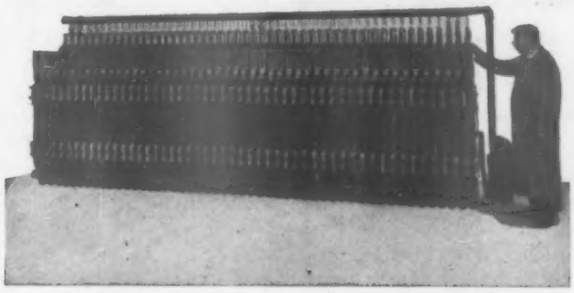

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Preheating Outfits for all requirements.

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